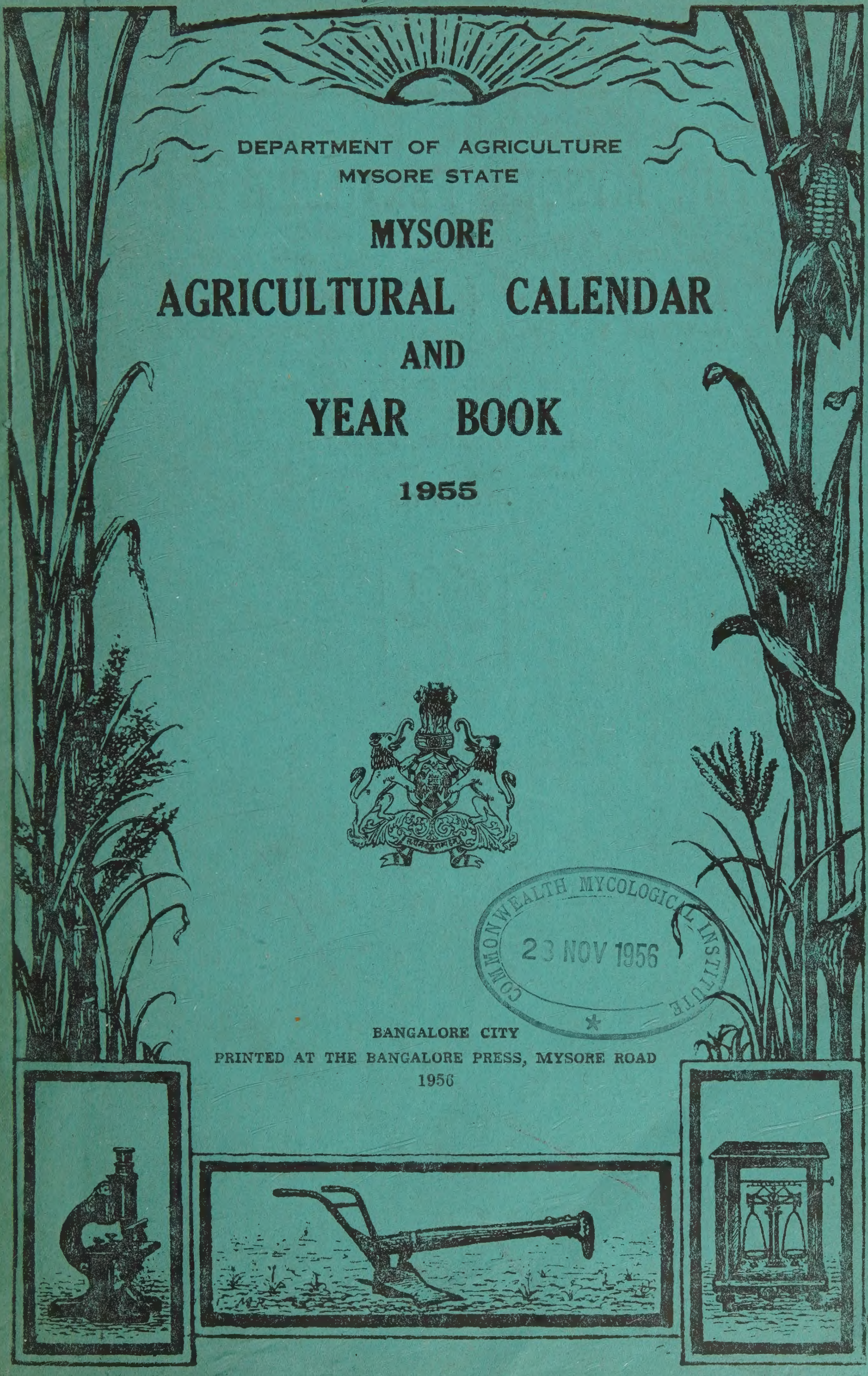

DEPARTMENT OF AGRICULTURE
MYSORE STATE

MYSORE AGRICULTURAL CALENDAR AND YEAR BOOK

1955

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MYSORE
AGRICULTURAL CALENDAR
AND
YEAR BOOK

1955

Editor:

M. L. N. IYENGAR

BANGALORE CITY
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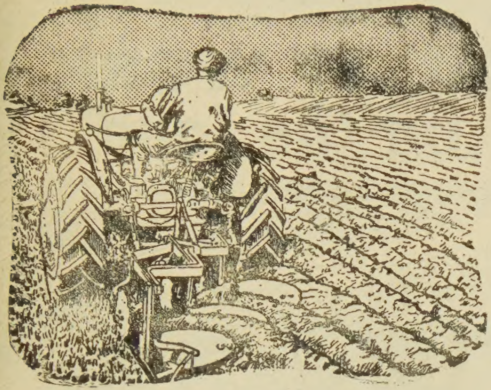

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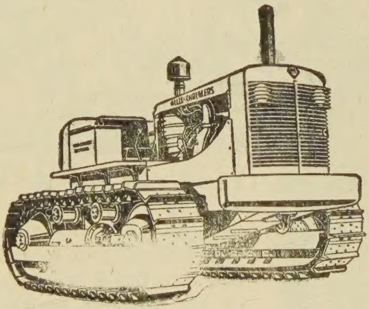

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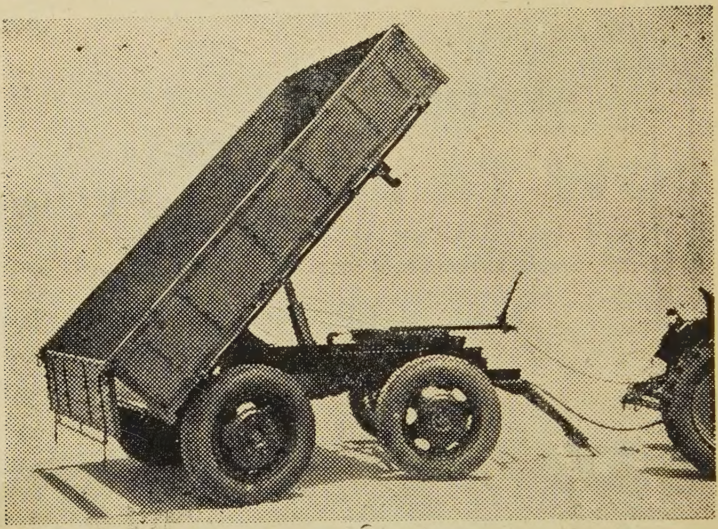

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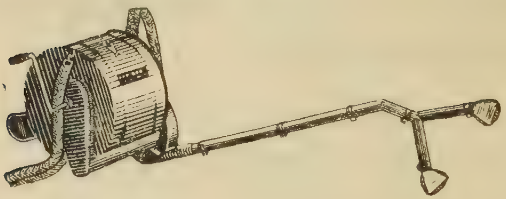

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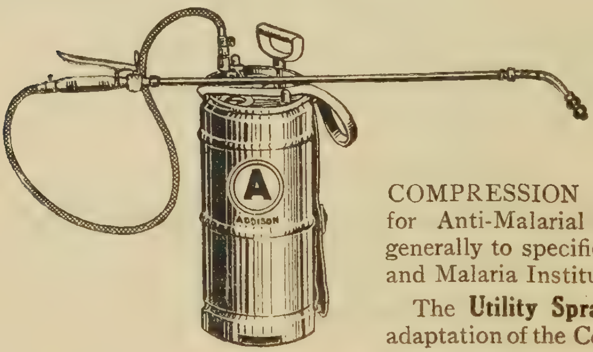

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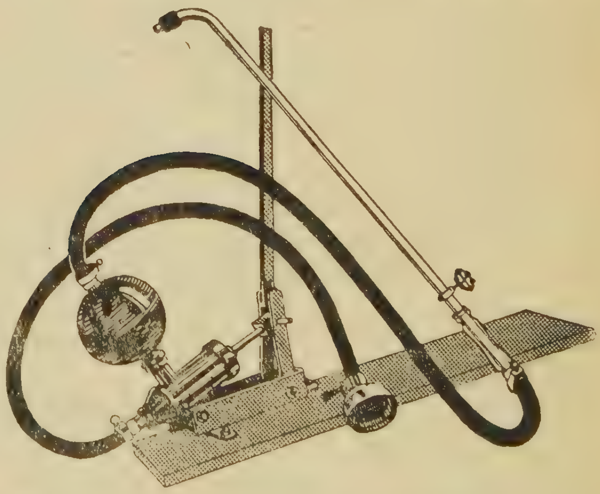

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DEDICATION

When the last edition of this *Calendar and Year-Book* was under production, Dr. Leslie C. Coleman, the first Director of Agriculture in Mysore State, and the founder of this annual publication, was on a visit to this State after a lapse of nearly 2 decades. He blessed our efforts in continuing this *Calendar* and in expanding its scope. On the eve of his departure to his native land of Canada, he gave a stirring message to our farmers and promised to send us another message for the 1955 edition. Before he could do so, he was killed in a motor accident on 14-9-1954.

Dr. Coleman is dead but his spirit animates every limb and activity of the Mysore Department of Agriculture which he built up with great devotion, care and effort. His name and fame have been woven into the fabric of Mysore Agriculture and will continue to inspire generations of workers in future years as they have done in the past.

This edition of the *Mysore Agricultural Calendar and Year-Book* is gratefully dedicated to the sacred and fragrant memory of Dr. L. C. Coleman.

EDITOR'S NOTE

This edition of the *Calendar and Year-Book* was scheduled for publication on 26th Jan. 1955, but has been delayed for over an year solely on account of the inability of the Press to which this work had to be entrusted to execute it. The work was later transferred to The Bangalore Press but by then several manuscripts and advertisement blocks were lost or mislaid by the first Press. I apologise for this delay and inconvenience to readers, authors and advertisers.

I am grateful to the Head of the Department for giving me this opportunity to serve the Mysore farmers. I thank all authors and advertisers for their ready co-operation and forbearance. I acknowledge the help rendered by my assistant, Sri. H. V. Venkatakrishnayya, in the production of this *Calendar*.

M. L. N. Iyengar.

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AGRICULTURE IN BELLARY—BACK GROUND AND REVIEW.

By C. M. REVANNA, B. Sc.,
District Agricultural Officer, Bellary

SITUATION, BOUNDARIES, ELEVATION & CLIMATE.

The Bellary District (7 *taluqs* with 638 villages) formerly attached to the composite Madras State is now the northern most boundary of Mysore State. It is bounded on the west and north by the Tungabhadra River and in the south and east by the Andhra State. Bellary District consists of two widely differing natural divisions—Eastern and Western separated by the Sandur Hills, which run right across the middle of the district from north west to the south east. The Eastern half of the district consists mainly of black cotton soil, while the western half contains scattered patches of black cotton soil and a greater part is covered with mixed and red ferruginous soils. The elevation of Eastern part ranges between 1,000′ and 1,500′ while the Western part is between 1,500′ to 2,000′ above sea level.

The climate of the district is hot and dry in the eastern *taluqs*, generally moderate in the western *taluks* The area of the district is 3,821 square miles with a population of 7,73,712.

SOIL CLASSIFICATION: PERCENTAGE IN DIFFERENT TALUKS

	Taluq	Black	Mixed	Red
1)	Bellary	80	....	20
2)	Siruguppa	62	26	12
3)	Hospet	8	90	2
4)	Kudligi	7	24	
5)	Sandur	10	24	66
6)	Hadagalli	20	47	33
7)	Harapanahalli	12	87	1

RAINFALL

Rainfall in the district is scanty and untimely. Though the district is situated within the influence of both the *monsoons* it does not, unfortunately, get the full force of either and hence the constant failure of one or the other and some times of both is seen. The average rainfall of the district is 23.74 inches.

South west *monsoon*: 14.0″ on average
rth east *monsoon*: 6.0″ ,,
Summer showers etc. 3.5″ ,,

SOIL CONSERVATION SCHEME.

Bellary District is situated in a tract where nature does not favour it with sufficient and timely rainfall.

Due to the unevenness of the fields in the district, wherever rains are received the top soil is being carried away, leaving the fields with many small streams in the first instance and slowly form them to gullies. ultimately making the lands unfit for cultivation. To prevent this soil erosion and also to conserve the moisture, a Contour Bunding and Soil Conservation Scheme was launched by the Madras Agricultural Department in Joladarasi village of Bellary *taluq*. The details of work done at the centre are as follows:-

The catchment of the area is about 5,760 acres and is spread over the villages of Joladarasi-Chellakurki, Yalpi-Kaggal, Paramadevanahalli, Minahalli, and Lingadevanahalli, Estimates were already prepared for an area of 1,415.19 acres and work has been taken in the village of Joladarasi-Chellakurki and Yalpi-Kaggal. The contour bunding work has been carried out in 1,380 acres. Cost of bunding has varied from Rs.85 to Rs. 105/-per acre depending on the slope of the land and the number of waste weirs that are built per acre. Half the amount is a grant from Government of India and the remaining half is the loan given to the ryots to be recovered in 20 annual instalments and the first instalment is to be collected 2 years after completion of the work, during which period the bunds will also be maintained by the Government. The concession of half of the cost of the work will be allowed only for those ryots who are willing to allow the Agricultural Department to execute land improvement works. The entire expenditure has to be borne by the ryots who desire to execute the work by themselves.

SEASONS

There are mainly two seasons for cultivation of crops in the district.

(1) *Mungari:*—Sowings conducted in June-July. Crops cultivated are:, *Navane*[1], *Jola*[2], *Mungari* cotton, groundnut, chillies, castor, paddy red gram[3], horse gram.[4]

(2) *Hingari*:—Sowings conducted in September-October. Crops cultivated are:-Cotton, bengal gram[5] *jola*, *navane*, wheat, and onions.

CROPS

The area under each crop for the district is given as follows:—
(Crop year 1952-1953)

(Total Cultivated area:—16.8 lakh acres.)

Paddy-I Crop	19,624	Sugar Cane-I Planted	7,860
,, II ,,	1,077	,, ,, II Ratooned	373
Wheat	4,471	Tobacco-Virginia	31
Jola-Kharif[6]	3,39,248	,, -Others	3,206
,, *Rabi*[7]	2,44,479	Chillies	5,323
Ragi	19,083	Plantains	214
Sajje[8]	63,966	Mango	994

---

1. Italian Millet: *Setaria italica* 2. *Sorghum vulgare* 3. *Thogari* : *cajanus cajan* 4. *Dolichos biflorus* 5. *Cicer arietinum* 6. Rainy season 7. Cold weather 8. *Bajra*: *Pennisetum typhoides*.

Navane Kharif	1,45,511	Castor		7,043
,, *Rabi*	16,740	Groundnuts		2,33,780
Total	1,62,251	Linseed		559
Same[1]	4,284	Coconut		1,357
Baragu[2]	468	Citrus		105
Bengal gram	9,352	Coriander		166
Horse gram	68,225	Vegetables		1,191
Black gram	209	Betel vines		326
Green gram	16.719	Cotton-Mixed-	*Mungari*	39,811
Red gram	25,036	,, ,,	*Westerns*	56,181
Field beans	660	Cotton-Pure	*Mungari*	9,047
Gingelly	5,678	,, ,,	*Westerns*	1,39,845
			Total acres	2,44,884
Safflower	12,301	Onions		1,800 (approx)

AGRICULTURAL PRACTICES

Agriculture is the subsisting factor for all the rural population and nearly 90% of the people are depending on agriculture alone. Out of the total area of 23 lakh acres nearly 84% of the area is arable and of the arable area 87% is under occupation. About 60% of the total area cultivated is devoted to the production of food grains, of which cereals and millets form 88% and pulses 12%. Cereals and millets consist mainly of paddy *jola, sajje navane* and ragi. *Jola* and *navane* occupy respectively 24 and 17 per cent. of the total cultivated area. The area under horsegram is more than that occupied by all the other pulses. Cotton and groundnut are the important industrial crops in Bellary and occupy nearly 13% and 10% of the cultivated area, respectively. Paddy is in larger areas in Hospet *taluk*. Sugar cane is raised in wet lands on a limited extent. The cane grown in Hospet area is utilised by the Sugar Factory at Hospet, while in other places it is converted into *Jaggery*.[3]

LOCAL AGRICULTURAL IMPLEMENTS AND PRACTICES

The local implements of the Ceded districts are a marvel. They are very simple and excellent. The blade harrow, the wooden seed drill, and the inter cultivating "*dantulu*" (Blade harrow) are very simple and efficient implements. They are well suited to the tract and to the bullock power available. They require to be improved in the direction of greater durability, greater ease of work and at reasonable cost. The cultivation practices adopted in this area are also peculiar. The two commonly used implements in this tract are (1) The "*Guntaka*"[4] or the blade harrow and (2) the "*Gorru*"[5] or the seed drill. The *Guntaka* is a wooden beam harrow with an iron blade, which is about 3½'. long. This is drawn by one pair of bullocks, and cuts the ground to a depth of 2 to 2½". This is used for preparatory cultivation, to bring the land to good tilth. Starting from summer rains in April-May, the implement is worked after every subsequent

---

1. *Panicum miliare* 2. *Panicum miliaceum* 3. Crude Sugar 4. Called in Mysore as *Doddakunte* 5. Called in Mysore as *Kurige*

rain, and friable soil free from weeds, to a depth of 2″ to 3″ is obtained by working it three or four times till the sowing period in September–October.

The seed drill or *gorru* is another wooden implement with six tynes, the tynes being 13½″ apart. The tynes have iron share points. The seed drill is used for sowing of *jola* and all the six tynes are made use of. When the *gorru* is to be used for sowing cotton, the alternate holes are blocked in the hopper and sown at 27″ apart. At the time of sowing this, *gorru* is followed by *guntaka* for covering the seed.

In addition to the two implements described above a set of inter cultivating implements is used to cultivate the inter space between the line of crops. These are just like *guntakas* but are smaller in size. The blade measures about 10″ to 12″ wide and fit the inter space of lines. 4 or 5 of them form one set and each of them is tied independently to the yoke to the proper place. This implement is locally called "*Dantulu*".[1] All these implements are suitable only for shallow cultivation, which is typical of the tract and they cover large areas. The *Guntaka* covers about 3 to 4 acres a day. The seed drill covers an area of 5 acres a day.

A set of four *danthies* cover about four acres a day. A farmer owning about 30 acres of land will have two *guntakas*, one seed drill and one set of *danthies*. A seed drill can manage 100 acres in one season. It is a common practice for farmers both small and big to co-operate during the time to sowing and complete sowing of all the land in their village by their combined efforts.

In deep black cotton soils of this tract, the type of common cultivation is shallow and extensive. Deep cultivation with a heavy plough (most commonly Kirloskar No. 9 plough) employing five or six pairs of animals and ploughing deep and raising big clods is resorted to only in such fields as have become foul by deep rooted perennial weeds like "*Hariali*".[2] Ordinarily ploughing of dry lands is resorted to only once in 3 or 4 years.

THUNGABHADRA PROJECT

The Thungabhadra Project in Bellary district gives irrigation for the following areas and acreages.

Taluks.	No. of Villages.	Area irrigated in acres			Total.
		Perennial.	Wet.	Dry.	
Hospet.	10	5,061.50	867.25	3,457.98	9,386.73
Bellary.	31	2,066.63	4,781.14	13,957.89	20,805.66
Siruguppa	79	8,204.78	12,072.67	41,874.71	62,152.17
Total.	120	15,332.91	17,721,06	59,290.58	92,344.55

The crops to be grown in the above said areas *namely* Perennial, Wet and Dry irrigated are as follows:

ZONAL SYSTEM OF THE *ayacut*.

The *ayacut*[3] itself is divided into three zones comprising of perennial zone of 15,000 acres, wet zone of 43,000 acres, and dry, irrigated zone of 1,92,000 acres. Water has now been let into low level canal on 1st July 1953, which has to be suitably utilised by the *ayacutdars*[1] in the different zones. Water will be allowed to crops throughout the year except for a short period of about a month for silt clearance in the perennial zone. The other two zones get water for irrigation only for nine months from June to February.

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[1] Called in Mysore as *Yedekunte* [2] *Cynodon dactylon* [3] *Achkat* or area commanded by the irrigation source

The *ayacutdars* in the perennial zone can raise any number of crops in a year, while those in the other two zones have to base their cropping on the availability of water. It is of particular interest for the ryots to note that the Govt. have waived all restrictions for the raising of fodder and green manure crops including water-cess for three *faslis*[2] from 1362 to 1364 (vide G. O. Ms. No. 487 dated 20th February 1952). This concession is intended to encourage the cultivation of enough fodder for cattle and to enrich the soil by the raising of green manure crops. The ryots are therefore advised to avail of this opportunity fully. The following crop rotations are recommended to be adopted with benefit, in each season.

CROPPING PATTERNS.

1. Perennial zone: Paddy and sugarcane crops of the varieties noted below against each can be grown in rotation. The other alternative is to grow annually two crops of paddy year after year, one of long duration and the other of short duration, for the main and summer seasons respectively. The third alternative is to grow a green manure crop followd by *samba* paddy.

Crop.	Variety.	Planting season.	Harvesting	Remarks
1). Paddy.	GEB. 24. or Akp. 2.	June-July.	Dec.-January.	First year
Sugarcane.	Co.419	Feb.-March.	Jan.-Feb.	Second year
Green manure crop	*Daincha*[3] or Sunnhemp.	April-May	June-July.	
Paddy.	GEB. 24 or Akp. 2.	June-July.	Dec.-Jan.	Thirdyear
2) Main season.		June-July.	Nov.-Dec	
Paddy.	Akp 2.			First year and repeated in second year.
Green manure crop.				
Summer season*			May	
paddy.	Co. 13.	February		
3). Green manure crop	*Sesbania*	March	June.	First year and repeated in second year.
Main season paddy.	G E B 24	June-July.	Dec-Jan	

*N. B:-In place of summer paddy, vegetables and onions can also be grown.

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[1] holders in the command area. [2] crop year [3] *Sesbania* sp

Any one of the three rotations suggested can be adopted by the ryots in the perennial zone, acording to convenience and market conditions for sugarcane and *jaggery*. If rotation I is adopted, each holding in this zone should be divided into two blocks for convenient rotation of paddy and sugarcane. In the main season Akp. 2. paddy is preferable to GEB. 24 because it allows sufficient interval for raising an intervening crop of sunnhemp due to its earliness in maturity by two or three weeks, besides being almost on par with GEB. 24, in quality and yield.

2. *Wet zone*:- The wet *ayacut* of 43,000 acres, is divided for early and late planting of paddy. The former will require water for planting from June onwards while the latter from September. The area is spread in the entire *ayacut* and only one crop of paddy year after year can be grown with the strains noted below for the early and late seasons:-

Crop.	Variety.	Planting season.	Harvesting.	Remarks
a) Green manureCrop.	Sunnhemp.	June.	July.	To be ploughed in in after seven weeks.
Early or main season paddy.	GEB. 24	July-Aug.	Dec.-Jan.	
b) Green manure crop.	*Daincha* or Sunnhemp.	June-July.	Aug. Sept.	
Late season paddy. type varieties.	ADT. 18. or MTU 15.	Sept.-Oct.	Jan. Feb.	

Late varieties Co. 2., or ASD. 5. Sept.-Oct.-March.

3. *Dry irrigated zone*:- This is the main area in the *ayacut* receiving water from June to February for any one crop only during this period as shown below:-

Particulars.	Crop.	Variety.	Sowing	Harvesting	Remarks.
a) Three-Year course rotation for deep soils.	G.nut redgram mixture.	TMV- 2. 2900	June-July.	G.nut can be harvested in Oct.-Nov. & red gram in Jan. Feb.	First year
	Mungari Jola	Co. 9.	June-July.	Nov-Dec.	Second year
	Green manure.	Sunn-hemp	June	July (to be ploughed in after seven weeks)	
	Cambodia cotton	Lakshmi	Middle of August.	March-April	Third year

b) Three year course rotation for deep and shallow soils.	Grounduut redgram mixture.	TMV-2, 2990.	June-July	G. Nut, Oct-Nov. Redgram Jan-Feb.	First year
	Navane	N. 1.	June-July	Oct-Nov	Third year
	Green manure	Sunn-hemp	June	July	Second year
	Cambodia Cotton	Lakshmi	Middle of August.	March-April	
c) Four-year course rotation for deep and shallow soils	Green manure	Sunn-hemp.	June-July	Aug-Sep.	First year
	Glumed wheat	Local.	Oct-Nov.	Feb-March	
	Groundnut redgram Mixture.	TMV-2., 2900	June-July	G. Nut, Oct. to Nov., Red-gram Jan.-Feb.	Second year
	Jola	Co. 9.	June-July	Oct-Nov.	3rd year
	Green manure	Sunnhemp	June.	July.	
	Cambodia cotton.	Lakshmi.	Middle of August.	March-April.	4th year

The *ayacutdars* in this zone can adopt any one of the above rotations suggested. It is possible to raise bengal gram as a dry rainfed *rabi* crop by sowing in November., in the same land soon after the harvest of *Mungari jola* which should be sown early in June and harvested in October-November. In place of pulse crop, he can grow a fodder crop if needed.

The above are the main lines of cropping pattern, including important food and commercial crops that can be grown successfully in the new *ayacut*. Other minor crops like chillies, vegetables, sweet potato, tomato, *bendai*,[1] brinjal,[2] onions maize etc. and fruit crops like papaya, pomegranates, sapotas, guavas, etc. can be grown in small areas according to requirements and demand. These crops come up well under irrigation in the black soils of the project. In place of Co. 9. *Jola*, the ryot can also grow N. 1. *Navane*. Both *Jola* and *Navane* are staple food crops of this area and supply fodder to cattle. If a ryot prefers to sow *Jola* in late season, variety M-31-2 should be sown in middle of September.

Varieties of improved strains recommended for growing in Bellary District.

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[1] Okra: *Hibiscus esculentus*

[2] Eggplant: *Solanum melongena*

(a) *Paddy*

Rainfed: (Kudligi-Hadagalli-Harapanahalli-Sandur) MTU 17 has been tried and found to fare well.

Irrigated: (Hospet-Sirugppua-Sandur-Kudligi) GEB 24 is well established and popular among ryots.

For Saline lands: S. R. 26 B is grown in the district.
Main crop: June-December G.E.B. 24
Summer paddy: January-April. ADT 3 and Co. 20.

(b) *Ragi*:	Irrigated – H. 1.	
	Dry – Co. 1.	
(c) *Sajje*	No suitable departmental variety.	
(d) *Jola*	Irrigated: Co. 9.	
		Black soils – No strain.
	Rainfed.	
		Red soils – H. 1. and M. 47-3.
	ed soils – H. 2.	
(e) *Navane*		
	Black soils – H. 1.	
	Spreading TMV. 1 and TMV. 3	
(f) *Groundnut*		
	Bunch TMV. 2	
(g) *Gastor*	TMV. 12.	
(h) *Sugarcane*	Co. 419.	

AGRICULTURAL DEVELOPMENT UNDER TUNGABHADRA PROJECT: A PROSPECT.

By S. RAJARATHNAM, B.Sc., (Agri)

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Tungabhadra Project is a multipurpose one to produce electricity to develop industries and storing flood water in the reservoir to develop agriculture. When plenty of cheap power is available, small and large scale industries can be started, properly utilising the raw products of cotton and sugar cane, raised in the *ayacut*.

Cotton Mill Industry:—With a view to develop industries; the *ayacut* is localised suitably to raise long staple Cambodia cotton—Lakshmi (Bombay strain) under light irrigation and manuring. This variety also comes up under dry land conditions, replacing the indigenous short staple cotton-*Westerns*. At the Agricultural Research Station, Siruguppa, Cambodia cotton had yielded 1,500 lb. *Kapas*[1] per acre and in the *ayacut* a normal average yield of 800 lb. *Kapas* per acre can easily be estimated which is about three times the yield of rainfed cotton. When cotton is available, cotton mills can be started, utilising the cheap electricity that will be available. More men also can be employed in this industry. Coimbatore district was well developed in the past two decades in cotton industry, mainly due to the availability of cheap Pykara power and raw products i.e cotton grown in that district. Similarly, the prospects for starting cotton mills in this area, are very bright and a good chance for the capitalist to start such industries. Labour also will be attracted on account of assured employment and the thinly populated area will become thicker in due course.

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[1] Seed Cotton

Sugar Mills:— In the Tungabhadra Project *ayacut* there is a perennial zone of 15,000 acres getting water supply throughout and they are localised round about Kampli and Siruguppa. In these two regions, there is already well developed old perennial *ayacut* under old channel, carrying the Tungabhadra water from the *anicuts*[1] constructed long ago and sugarcane and paddy are the two major crops in the old *ayacuts*. The new and old perennial *ayacuts* will give ample and more sugarcane, a raw product highly essential for sugar industries. The total area under cane is expected to be about 7,000 acres in each of the two regions or centers. One 800-ton capacity sugar mill can be started easily at Kampli immediately, since there isf an area of about 3,000 acre cane under old *ayacut* itself. The factory o 800-ton capacity will require about 4,000 acres cane. The prospects are very bright in this village. Another mill of the same capacity can be started at Siruguppa, head quarters of the taluk, in about two or three years, as the *ayacut* develops. The present area under cane under old *ayacut* is about 12,000 acres. Thus there are possibilities for opening two sugar mills of 800-ton crushing capacity a day one at Kampli and another at Siruguppa. The only bottle neck in the rapid development of sugar industry is the rail transport, for which the Central Government should help the backward areas in giving rail connections between Daroji to Kampli and another line from Siruguppa to Adoni. This will go a long way to help the industrialist in launching such schemes. Internal village communications are also of utmost importance to transport cane from villages to the factory. Sugarcane cess of Rs. 6 -per ton is being collected by the State Government and road communications can be developed and improved in due course with this cess. Along with industries, communications also should be well developed in the new *ayacut*.

Agricultural Development:— Agriculture will be well developed in the *ayacut*. There is assured water supply and successful cropping is the result of such an irrigation system. The chances of crop failure in the *ayacut* are far remote. The *ayacut* is so localised, that the agricultural operations will be spread throughout the year in the perennial zone and over a longer period in the wet and dry cum wet zones. The labour will thus get employment for more number of days in an year. The intensive cultivation and assured cropping with the gradual development of big and small industries in the *ayacut* will certainly improve tbe economic condition of the ryots in this region in due course. New crops like Cambodia cotton come up well under irrigation and long staple cotton is highly needed in place of short staple cotton. Other crops like vegetables, wheat, groundnut, chillies, onions etc are coming up successfully and such a careful cropping including green manure crops to enrich the soils, money crops, food crops and fodder crops will surely enrich *ryots* in a decade. Already people from Guntur and Krishna districts have come to this new area and purchased lands to take

[illegible]

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[1] Low dam

up agriculture and such migrations will be common to newly developing areas from the thickly populated regions. The local people should rise up to the occasion to develop agriculture to benefit them.

The State also will render necessary help to *ryots* by way of loans to purchase cattle, implements, construction of cattle sheds; improving lands by laying bunds and irrigation channels by proper levelling. The *ayacutdars* should avail these concessions to develop agriculture. Thus with the development of industries and agriculture, the population will increase, economic position will improve, all will get employed over a longer period in an year; famine conditions will vanish; food problem will be solved, meeting the demand of ever growing masses; cattle wealth will increase resulting in more supply of milk. The indirect revenue in such developing project area is not a small sum, as trade also will improve, with the agricultural improvements turning the country green. With the starting of National Extension Schemes in Siruguppa taluk in October 54 and posting of special staff for *ayacut* development, quick results can be achieved with the co-operation and good willingness of the people of the tract.

AGRICULTURAL RESEARCH STATION, HAGARI.

RESULTS ACHIEVED

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Superintendent, A. R. S., Hagari.

INTRODUCTION

The Agricultural Research Station located at Hagari in Bellary district is a Dry Farming Station confined to the researches with crops raised under rainfed conditions and thereby catering to the needs of the local cultivator. The average annual rainfall of this tract is about tweny inches with famine occuring once in four years.

The black cotton soils of this tract is of a granitic origin with the *pH* value ranging from 8. 5 to 9. The percolation of rain water is very slow at first due to the heavy nature of the soil but improves when the percentage moisture reaches 25 for any layer. Studies on the temperature of the soil revealed that the effect of diurnal variations in the temperatures is the maximum in the top six inches layer of the soil. Below 24″, changes in temperatures due to daily heating and cooling ceases to exist. Studies made on the seasonal variation in the nitrogen contents have revealed that the total nitrogen content attained the maximum owing to its depletion by the standing crop of *jola* and cotton and again attains the maximum value in April after the harvest of crops thus indicating the recuperative capacity of the soil, in the nitrogen contents. After reaching the full capacity for moisture in October, the top 12″ layer of the soil is subject to sudden drying during the dry period following, with the result that a hard layer varying in depths from 6″ to 9″ will be formed below the top 3″ layer of the soil.

RESULTS ACHIEVED

With these initial studies on soil, the crop improvement work was initiated and two important strains, one in *jola*-H. 1. and one in Cotton-H.1. were evolved and released in 1918 and 1927 respectively. H. 1. *jola* is a pure line selection from the local *bile jola* grown under rainfed conditions. The stalks are juicy and sweet. The ear heads are oval, compact with white pearly grain. This strain is sown in late season called *Hingar* season commencing from August-September. Pure line selection work carried on at this station since 1908, resulted in the isolation in 1930, of a strain in cotton (H. 1.) intended for late season, which marked a substantial improvement over unselected local cotton. H. 1. cotton has a staple length of 13/16″ with an average ginning percentage of 30 and can spin upto 25 counts. It has a very good gloss, is white in colour and silky.

A short duration strain in *jola*-M. 47-3, very fruitful in seasons of deficient rainfall was introduced in 1940. Two strains H. 1. and H. 2. in *Navane* and one strain H. 1. in ragi were released in 1938. M. 47-3 *jola* is a strain from Mohal, Bombay. This is shorter in duration than H. 1. *jola* by about a fortnight. Its grain yields are higher than the straw yields. In seasons of deficient rainfall M. 47-3-*jola* gave a fair yield of grains when H. 1. failed to produce ear heads. The stalks are juicy and sweet. The ear heads are loose, with bold white, pearly attractive grain. H. 1. *navane* comes up well in sandy and red soils. It tillers well and is green throughout without any purple colour on the plant. It is easily distinguishable by its green colour and the bristles on the ear heads, which are shorter at the bottom and medium at the top. H. 2. *navane* comes to maturity earlier than the H. 1. generally suitable for black soils. It is easily indentified by long compact, attractive ear heads, with short bristles. H. 1. ragi raised under lift irrigation is a mutant from E. C. 593 differing from the parent in having the incurved earheads.

A large number of selections in *navane*, *jola* and cotton, in addition to huge hybrid material are under intensive study. In *navane* H. K. 282 and H. K. 289—improvement over H. 1. and H. 2. *navane* are under observation in the cultvators' fields. J. 744 and J. 718 in *jola* are also under observation in the *ryots*' holdings.

H. 1. cotton strain was found to suffer in years of deficient rainfall and recorded low yields, fall in staple length and increased waste in the processing stage. A scheme to improve the quality and increased staple length capable of spinning 30s warps in normal seasons was started in 1949. under the trade name as "Westerns Cotton Improvement Scheme" financed by the Indian Central Cotton Committee and State Government The work is now in advanced stages of breeding.

The Agricultural Research Station, Hagari, Brucepet, Bellary is situated near the Yalpikaggal Village in Bellary Taluk on the Madras-Bombay Road. The Hagari Railway Station is one and half miles from the Farm. The Station was started in 1906 and is therefore the second oldest farm in the State, the oldest being the Hebbal Farm started in 1904. The annual expenditure on the Station is Rs 59,000 and the receipts are Rs 27,000, The cultivated area of the Station is 200 acres—Ed.

AGRICULTURAL RESEARCH STATION, SIRUGUPPA. RESULTS ACHIEVED

By S. RAJARATHNAM, B.Sc. (Agri.)
Superintendent, A.R.S. Siruguppa

INTRODUCTION

The Agricultural Research Station at Siruguppa was opened in 1937 to solve the problems of Tungabhadra Project. Extensive soil survey was conducted in the commandable *ayacut* of 1,600 square miles under Low Level Canal and High Level Canals; taking soil profiles at the rate of one per four square miles, to study the nature of soils, sub-soils, up to a depth of 6 to 8 feet till *garusu* layer or stone. Soils were also analysed in the laboratory to study the salt content at various depths in the profiles. Literature was also gathered about irrigation in black soils in other states and countries. As a result of extensive soil survey, study of salt content of soils together with their physical properties, nature and quality of irrigation water, and literature studied; it was pronounced that black soils of Bellary district are irrigable and to test and confirm the laboratory findings on a field scale, this Station was started to study (1) the physico-chemical reactions of deep and shallow black soils under light and heavy irrigations, (2) to lay agronomic experiments to determine the economic rotation of crops, soil management; manurial requirements of crops, introduction of new crops; and duty of water for the tract for various major crops to be grown in the *ayacut*.

ACHIEVEMENTS

Soil studies:—There was a feeling of doubt about the development of alkalinity and bringing of salts to the surface as a result of rising of water table after some years, on introduction of irrigation in black soils of the tract. since the sub soils contain salts far above the toxic limits. Investigations conducted from 1938 revealed, so far, no appreciable rise of salts to the surface under light and heavy irrigations. Results of analysis of Tungabhadra water conducted at monthly intervals, over two seasons, clearly indicate that the water is good for irrigation, since it contains only 7 to 27 parts of salts in 100,000 parts as against 200 parts in 100,000 which ratio is considered to be the toxic limit for most of the cultivated plants. Study of crop tolerance to salts at this station show that cultivated crops tolerate soils having salts up to 0.2% and not more. Soil moisture studies were conducted and they show that moisture levels were confirmed to oscillate only in the top 2½ feet of soil profile and below this zone, moisture level was found to be constant even in summer. Again, it was observed that there was no under accumulation of moisture in the black soils as a result of irrigation and any excess moisture over and above 35 to 40% gets easily drained off through highly pervious *garusu* layer lying below black soils. The *ayacut* also lies on an undulating land, where there are good number of natural *hallas*[1] and *vankas* to drain away the surface water during rainy weather. From these findings, it was declared that no salinity will result in the black soils on giving irrigation.

Duty of water in the Command area:—Duty was determined for all the crops to be grown in the *ayacut* and as a result of these studies on this subject at this Station over a number of years, the *ayacut* is localised at 50 wet and 160 dry cumwet crops for every *cusec* of water. Generally wet land crops of paddy, sugarcane used to be raised in any project *ayacut*; but this is the first *ayacut* where 4/5ths of the area is to be raised with crops under light irrigation, with a view to have a higher duty, giving benefits of irrigation over a larger area in more number of villages taking into consideration the thin population of the village to cope up with the demands of increased labour force required for cultivation under irrigation. The main idea of the project is to avert famine which occurs frequently due to failure of rains and ill distribution of the same. In the *ayacut* there are good chances for raising assured crops giving irrigations when rains fail.

Manurial Experiments:—Manurial experiments conduced at this Station show that no spectacular yields could be achieved with irrigation alone with out manuring and again with manuring and without irrigation. Both irrigation and manure are essential to increase crop yields. Crops like cotton *jola, korra* (navane), *paddy*, vegetables respond well to 40 lb. N[1] per acre in the form of ammonium sulphate over a basal dressing of 5 tons compost or cattle manure. If these are not available green manure crop of sunn-hemp should be grown and ploughed in to enrich the organic content of soils. This gives, in about 50 days, an average yield of about 8,000 lb. per acre. It is advisable to apply 40lb.P per acre in the form of super phosphate to green manure crop. Soils are poor in nitrogen and phosphorous. Nitrogen, phosphorous and potash are the important plant foods and they should be supplied to get better returns. Doses of 200 lb. N are recommended to sugarcane crop in two doses of 40 lb. N to be applied 35 to 40 days after planting and the balance of 160 lb. N during 4th month prior to earthing up of crop.

Microbiological studies indicate increase in bacterial population from year to year as a result of irrigation. Studies on the intensity and frequency of irrigation show that 2′ of water once in 15 days is the optimum for crops under light irrigation raised during June to February. Too many irrigations at shorter intervals and too few irrigations at longer intervals, will lower the yields of crops.

Agronomic experiments:—Time of sowing experiments revealed that it is advisable to sow Cambodia cotton during 2nd fortnight of August and *hingari jola* during second fortnight of September to get maximum yields. For late season planting, 2nd fortnight of September is the right period for planting paddy seedlings to get higher yields. Cultural practices indicate that ploughing is essential for each crop and the time honoured practice of giving deep ploughing once in 4 to 5 years in dry land cropping had to be suitably changed to crops under irrigation. The implements and tools that are used in dry land cropping could be used also to cropping under irrigation. New implements like bund former, ridge plough, cultivator and buck scraper if obtained will go a long way for the new method of raising crops under light irrigation and use of such labour saving implements will reduce the cost of cultivation.

Rotations:—The following rotations are recommended for the three zones.

i. Perennial zone: (a) Two crops of paddy in an year; main season paddy (July to December)
Green manure followed by summer paddy (February–May)

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[1] About 200 lbs. of ammonium sulphate

(b) Two year rotation of sugarcane (March to Feb.) followed by green Manure (April to June) and paddy (July to December)

(c) Paddy followed by summer vegetables.

ii. Wet zone: Early season paddy (July to December) Late season paddy (September to March)

iii. Dry cum wet zone: Cotton, groundnut-redgram mixture, *jola* (Three year rotation) or green manure followed by wheat groundnut-redgram mixture; *jola* and cotton (four year rotation).

Suitable Strains for the Tungabhadra Command area:—Extensive trials were conducted to determine suitable strains for the *ayacut* and the following are recommended.

Paddy:	AKP. 2; GEB. 24: June-July season. ADT. 18 or MTU. 15: September-October season. Co. 13 or MTU. 15: for summer season.	
Sugarcane:	Co. 419,	
Jola:	Co. 9 for *Mungari* June-July sowing. M-31-2 for *Hingari* September sowing.	
Navane:	N. 1: June-July sowings.	
Cotton:	Lakshmi (Bombay strain). August-September	
Groundnut:	TMV. 2	(June-July sowing)
Castor:	TMV. 2	,,
Gingelly:	TMV. 2	,,
Redgram:	2900 and 37	,,
Wheat:	No strain but Glumed Wheat (local) comes up well when sown in October-November.	

Green chillies, tomato, *bendai*, sweet potato, tapioca, brinjal, big onions, Lab-lab[1] (kitchen varieties) are coming up well giving good yields and profits. Maize and teosinte are recommended for fodder crops in June-July sowings. Guinea grass and Napier grass for fodder have done well under sullage conditions and irrigation. Among fruits, pomegranates, papayas and guavas have done well on the farm. Good seeds are being multiplied and supplied to *ryots* through district staff of Bellary. About 60,000 lb. of seed is distributed annually.

Green Manuring—Green manuring is the only way of enriching the soil with humus. *Sesbania speciosa* grown in single crop land for about 12 weeks growth had yielded 18,000 to 20,000 lb. of green leaf per acre; while *daincha* and sunnhemp for 7 to 8 weeks growth had yielded 8,000 to 15,000 lb. green leaf per acre. Super to supply 40 lb.P per acre should be applied by placement method prior to sowing of green manures (i.e.) in an ***akkadi***[2] behind a country plough.

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1. ಚಪ್ಪರದವರೆಕಾಯಿ 2. *Sadde*-a single tyned seed drill made of a hollow bamboo with funnel

Entomological studies:—Entomological trials have shown that jassids and aphids on cotton; thrips on chillies and onions; earhead bug on *Jola* and paddy; case worm on paddy, which are major pests could be controlled successfully by spraying and dusting with Gammexane (BHC). *Atherigona indica* or *Cholam* fly is a major pest on *Hingari jola;* and to control this pest, the time honoured method of sowing thick and thinning the affected plants after 4 weeks, is the best method. Strain M-31-2 is resistant to this pest to some extent, probably due to early formation of silica in this strain.

Plant Breeding:-In breeding work of cotton and millets[1] carried out by the Assistant Cotton Specialist to evolve suitable strains for the tract, the notable achievements in cotton, are evolution of strains 2196-4 (B.C. 134 X C.W) resistant to black arm and 1821-1-1 (B.C. 68) resistant to jassids. These strains are being crossed with other varieties, to improve the yield character. Work on millets is in progress.

Levelling and Bunding for irrigation:—The Agricultural Station, Siruguppa is an eye opener for the project *ryot* to divide a holding suitably into small blocks of 30 to 50 cents depending on the nature of gradient by terracing and laying the permanent irrigation channels along the contours to facilite irrigation to each block. Large scale levelling is not required in dry cum wet zone, since bed and furrow system of irrigation are recommended. The bed size should be about ¼ to ⅓ cent in area. Where little levelling is badly required, buck scraper could be used to level small mounds here and there. Grass should be planted on bunds for binding soil and this gives periodical cuttings of green grass for cattle. On the farm of 70 acre cultivation, 2 lakh pounds of grass are cut annually. Perfect levelling is necessary for paddy while fair amount of levelling is more than enough in dry cum wet zone. Soil should not be disturbed for more than 9" to 12" depth while levelling, since sub soils are poor and contain more injurious salts harmful to plant growth.

Experinents to find out optimum dose of N and P. and method of application of manures to crops; effect of P on green manure; kind of green manure crop to be grown; rotational experiments; fundamental experiments; salt contents of drainage water are all in progress and it will take time to get the results.

A visit to this station by project *ryots* and others is solicited to know more particulars. The officers in charge will receive them explaining the work turned out on the station for the benefit of the ryots.

The Agricultural Research Station, Siruguppa is one and half miles from the town of the same name on the Siruguppa-Adoni Road, 36 miles from Bellary and 24 miles from Adoni. The Thungabhadra river flows a mile away from the Station and water is pumped into a masonry reservoir in the Station from a channel fed by the river. The annual expenditure is about Rs. 78,000/- and receipts amount to about Rs. 20,000. The area of the farm is 92 acres of which 70 acres are clutivable.—Ed.

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[1] This work is reviewed in two later articles in the Calendar.

SUGARCANE DEVELOPMENT WORK AT HOSPET.

BY K. LAKSHMINARAYANA BHATTA, B. Sc.,
Superintendent, Sugarcane Liaison *Farm*.

INTRODUCTION.

Hospet is known as a centre of cane production and as an important *jaggery* market in the South. The average area in Hospet Taluq at present is 7,500 acres of which the crop from about 3,500 acres is utilised by the Hospet Sugar Factory which has a daily crushing capacity of 700 tons. The rest of the area is utilised for the manufacture of *jaggery*. The cane fields are irrigated by old channels of the Thungabhadra river, dating back to the days of the Vijayanagar Empire and as the supply of water, particularly at the tail end of the channels, was not always adequate, the area of cane grown till now was limited to the available water. Now that the Thungabhadra Dam is completed, supply of water in these old channels is assured and more cane may be expected to be grown under them. Also, the new reservoir brings under perennial irrigation another 5,000 acres in Hospet Taluq and a good part of this new area may also be expected to come under this crop.

It was thus quite natural, that when the Indian Central Sugarcane Committee sponsored their Sugarcane Development Schemes as part of the National Five Year Plan, the Madras Government selected Hospet Taluq as one of four important centres for intensive work on sugarcane development. The Scheme was put into operation here in March 1949 and continued upto October last year under the Madras Government. On the merger of parts of Bellary District in Mysore, the development work, in so far as it relates to Hospet Taluq was transferred to the Mysore Department of Agriculture.

As Hospet is an important centre for the production of both sugar and *jaggery*, the Scheme envisages development work in both factory gate areas and *jaggery* areas. Of twenty nine villages in the taluq which habitually cultivate sugarcane, only about sixteen villages lying within a radius of 6-7 miles supply cane to the Factory. As a party interested in the development of the sugar industry, the local Sugar Factory co-operates by financing partly, the maintenance of an experimental Farm.—The Sugarcane *Liaison* Farm—Hospet, and by providing facilities for testing new varieties in their mills. The salaries and allowances of the staff employed on the experimental Farm, and on extension work in the villages and other incidental charges are met jointly by the Indian Central Sugarcane Committee, and the State Government. The cane growers also whole heartedly co-operate in conducting tests and demonstrations on their fields, providing the labour and material for the same.

The programme of work followed is two fold. Field experiments are carried out on the *Liaison* farm—to find the suitable varieties, cultural practices and manurial requirements, with particular reference to conditions prevailing at Hospet. The results of these experiments are then carried to the cultivators through a system of propaganda and demonstration plots organised on their own fields. Demonstrations and propaganda on improved implements, methods of cultivation, plant protection practices, compost making, *jaggery* manufacture, etc., which are common to cane cultivation everywhere, is also done by the extension staff. Along with these, additional activities, such as prize competitions to encourage better cultivation, and yield surveys to assess the improvements achieved, are also carried out. In the implementation of this programme, every effort is made to maintain a close *liaison* between the cultivators, the factory and the Agricultural Department.

An attempt is made here, to indicate briefly the lines of approach followed with reference to the several problems connected with the sugar cane industry and to outline the main results obtained both on the *Liaison* Farm and on the fields of cultivators.

GENERAL CONSIDERATIONS.

The sugarcane soils of Hospet are mostly typical black soils, clay loam in texture and fairly fertile. They lie along the right bank of the Thungabhadra, which skirts the taluk in a wide semi-circle from Hospet to Kampli, 19 miles away. The fields are mostly flat and extend inwards from the river bank to a depth of 1 to 1½ miles. Beyond this level black soil patch, one meets with rising ground, with red soils, sand to sandy loam in texture. Some cane is grown in these red soils also, but the major acreage is on the black soils. These lands are irrigated by a number of channels from the river which are in use for the past four centuries or more. These take off at different points along the river, the total area irrigated by them being 15,000 acres, of which roughly half is annually under sugarcane. The rainfall here is low, the average being 20", although in some years the total precipitation has been more than 40". The rainy season is from May to October. Despite the availability of irrigation and the high moisture retentivity of the soils, a good crop is assured only when the rainfall is timely and well distributed. The growing season is short and cane becomes ripe for milling in about eleven months. The usual planting season is from February to April, but during the past few years, the season has been advanced to December, specially in the factory reserved area. The variety in cultivation is Co. 419. In the interest of cheap and quick transport, the supply zone to the factory is fixed in close proximity to it, the farthest villages reserved being Humpi and Kamalapur which are 8 miles away.

THE SUGARCANE *Liaison* FARM.

The Sugarcane *Liaison* Farm is in Hosur village, one of the villages reserved to the Factory and 1½ miles from Hospet. The soils are typical black clay loam and representative of the locality. It is served by the Raya Channel. The area of the farm is limited, being only 20 acres, which is taken on lease for a fixed rent. The farm lies on the Hospet–Hosur road and is easily accessible.

Considering the small area of the Farm, the number of experiments that can be carried out are limited. Even so, quite a large number of them, dealing with the varietal, cultural and manurial aspects of cane cultivation have been carried out during the past five years. The main conclusions are set out below–

(1) *Varietal experiments* : The variety in cultivation at present is Co. 419. Varietal experiments on the Farm are carried out to select varieties which (i) yield more than Co. 419. (ii) mature earlier and give a better quality juice and (iii) keep on the field for a longer period without

deterioration. In the Factory Zone, it is necessary to have varieties which mature at different periods of the season, so as to enable the factory to work over an extended crushing season. The selection of suitable early, mid season and late varieties are therefore, also kept in view. The results so far, available show that of more than twenty varieties critically tested none has out yielded Co. 419. A few like. Co. 449 and Co. 475 give the same yield as Co. 419. Considering earliness and quality Co. 449 is superior to Co. 419 as it ripens about a month earlier and gives a slightly higher (O. 3% to O. 5%) recovery in the factory. It is also resistant to smut to which Co. 419 is susceptible. For crushing in the early season, attempts are being made to popularise this variety. Co. 419 is still the best as a mid season and late variety.

Hitherto, only such Coimbatore varieties as proved out-standing at the Anakapalle Research Station were being tested on this Farm. From this year, it is proposed to include also both Mysore and Coimbatore varieties, which have been found to be good at V. C Farm, Hebbal and Babbur Farms, in Mysore State and other varieties doing well in the Bombay Deccan.

(2) *Manurial Experiments* :—These include, comparison of varying doses, and kinds of manure and different periods of applications. Experiments with graded doses of nitrogen rising from 50 lb. to 300 lb. by steps of 50 lb. each, indicate that 250 lb. of nitrogen per acre is optimum in this area. As regards time of application, application in two equal doses, once after germination is complete (about 40 days after planting) and again at earthing up (3½ months after planting) seems to be the most beneficial. Comparison of different proportions of ammonium sulphate and groundnut cake have shown, that combinations containing cakes and ammonium sulphate in the ratios 1:2, 2:3, 3:1 and 0 : 1 (on nitrogen basis) are equally effective in so far as the yield factor is concerned The combination at present recommended is the one containing ½ to 2 3rds of the nitrogen as oil cakes and the remaining portion as ammonium sulphate.

The possibility of supplying part of the total nitrogen requirement in the form of green manure has been studied. For this purpose, *Sesbania* and Sunnhemp were grown in between cane rows and green matter equivalent to 50 lb. of N. were incorporated into the soil at the time of earthing up, the rest of the nitrogen (200 lbs) being given in the form of oil cakes and ammonium sulphate. Another set of plots received *Hongay* leaves brought from outside, instead of green matter grown *in situ*. The yields obtained were compared with that in which all the top dressing consisted of oil cakes and ammonium sulphate alone The results over the past three years have not been conclusive, but the evidence is generally in favour of the use of sunnhemp and *Sesbania* Apart from the yield of cane obtained, these plants grown *in situ*, keep down weeds and lessen the cost of cultivation, and add to the humus content of the soil.

The usefulness of inorganic fertilisers other than ammonium sulphate has also been studied. In a comparison of ammonium sulphate and chilean nitrate, it has been found that at equal nitrogen levels, both fertilisers are equally effective. As the experiment has run only for two seasons further confirmation is necessary.

Applications of phosphate have not shown any response by way of increased yields or sugar content.

(3) *Cultural experiments* :– These include comparison of seed rate and spacing; comparison of pit method, trench method and furrow me-

thod of planting and comparison of top setts and *Rayungans* as seed material. A seed rate of 12,000 setts of 3 buds, and spacing of 2′,9″ between furrows is found to be optimum. The experiments with *Rayungans* show that top setts are as good or slightly better than *Rayungans*, and the latter has the additional disadvantage of requiring special care during the early stages of growth.

Other experiments :—Besides the above, experiments on irrigational requirement, crop rotations to be followed, effect of different times of planting and harvest, comparison of different methods of ratooning etc, are in progress and useful information on these points may be expected in due course.

EXTENSION WORK AMONG CANE CROWERS .

The work is directed mainly towards the introduction and popularisation of improved varieties and methods of cultivation, correct manuring and plant protection practices. In the *jaggery* areas, efforts are made to popularise double-pan furnaces run entirely on begasse and the correct use of clarificants for obtaining quality *jaggery*. In addition to this certaini tems of work of general interest are also carried out. These include an yield survey of sugarcane, a disease survey and organising of crop competitions.

The progress achieved in different fields of development and associated activities is presented below, with the achievements during 1953-54 in each case.

PREPARATORY TILAGE AND AFTER CULTIVATION.

The advantage of deep ploughing with iron ploughs is being constantly brought home to the cultivators. The use of country ploughs is still common and the stiff soil and the poor condition of draught animals often make this inevitable. But the importance of deep ploughing is being increasingly realised and during the current season, it is estimated that iron ploughs were used on 680 acres. Similarly, the replacement of manual labour by bullock drawn ridgers for earthing up is being advocated. The total area worked by ridger this season is estimated to be 1,700 acres.

Optimum spacing :—The tendency of cane growers in Hospet is to plant close, leaving a distance of 1. 5′ to 2.0′ only between furrows, the general impression being that wider spacing fails to give a close stand. The defect actually lies with faulty germination, as little or no care is taken in the selection of planting material. This fact is being brought home to them, and they are being advised to use good setts and adopt a wider spacing. Experiments on the *Liaison* Farm have shown that the spacing between rows can be as wide as 3¼ feet without a lowering of the yield. In the light of this, demonstration plots have been laid out where spacings of 2½′ and 2¾′ and 3. 0′ are compared. The total number of such plots this year is 85. The average yield obtained in these plots is shown below.

Average yield of cane (in tons per acre) under different spacings.

No. of plots harvested.	2′.6″	2.′9″	3′.0
85	40.9	42.0	43.2

The results obtained on their own fields during the past years have impressed cane growers and the prejudice against wider spacings is being gradually overcome. It is estimated that an area of over 700 acres have been planted during the year under a spacing of 2'.9"?

Optimum seed rate :—The results of experiments on the *Liaison* Farm have fixed the seed rate at 12,000 setts per acre and this is being advocated. An area of 470 acres was planted with this seed rate during this year.

Seed Nurseries :—The cane growers of the locality have begun to realise the importance of using setts from young and vigorous crop for seed purposes, instead of using part of the mature crop for the purpose. About 150 acres were planted during the year for seed purposes, the plantings being done mainly in the months of May and June. The extension staff inspected these plots pariodically for smut and borer attacks and helped in eradicating them.

Selection of variety :—As a result of field trials on the *Liaison* Farm during the past 3 years Co, 449 has been found to compare favourably with Co. 419 in point of yield and is slightly superior in point of sugar content. It is also noted for its earlier maturity and its relatively high resistance to smut. Attempts have therefore been made to introduce this variety into cultivation on as large a scale as possible. For this purpose demonstration plots were organised on cultivators, fields in which Co. 449 and Co. 419 were compared under idential conditions. In a few plots Co. 527 also was included. A total of 31 such plots were started during the year, of which in 25 plots Co. 449 and Co. 419 were compared and in the remaining 6 plots Co. 527 was also included. The results of harvest showed that Co. 419 gave the best yield followed by Co. 449 and then by Co. 527.

Cultivators are not enthusiastic in changing over to Co. 449 in preference to Co. 419 as it is not clearly superior to Co. 419 in yield. Other disadvantages they aver are that the cane is hard and difficult to harvest and that the tops are very coarse and consequently useless for fodder. A few cultivators on whose fields the variety has done very well have taken to growing it in bulk and further progress along these lines is being attempted.

The average yield of the three varieties were found to be:—Co. 419. 40.3 tons; Co. 449—38.0 tons and Co. 527—36.7 tons.

MANURES & MANURING

Farm Yard Manure:—The application of fairly liberal quantities of farm yard manure, (20-30 cart loads per acre) is a recognised practice in this area and goes a long way to maintain the soil fertility. In fields readily accessible by road, larger amounts upto 50-60 cart loads are also applied. While recommending the continuance of this good practice, cultivators are being asked to supplement it with compost and green manures as far as possible.

Green Manure :—Results of experiments have shown that green manure can replace to a certain extent concentrates, as a source of nitrogen. Apart from this, application of green manures improves soil texture, and builds up fertility. The sowing of a green manure crop and its incorporation into the field before planting cane is being recommended. Where there is not sufficient time to grow a green manure crop before cane, culivators are being encourged to grow it on the ridges between cane furrows and incorporate it into the soil at the time of earthing up. The chief green manures used for this purpose are sunnhemp and *Sesbania*. About one hundred acres of cane fields were treated with green manure in this manner during the year. Demonstrations on the growing of green manures in cane rows were held on fields of 18 cultivators.

Compost :—Cane trash at present is not being composted properly by the *ryots*. Most of it is used for fuel and a little as bedding for cattle. The correct method of obtaining good quality compost from trash has been demonstrated and farmers are encouraged to prepare compost on a large scale. Addition of press mud to the compost is being advocated. A total of 223 demonstrations, was held on the fields of cultivators, who provided the labour and other facilities and worked under the supervision of the development staff. Over 1,000 tons of compost was prepared.

DEMONSTRATION PLOTS.

To bring home to the cane growers the importance of higher levels of manuring, demonstration plots were organised in their fields, in which their practice was compared with the application of 200, 250 and 300 lb. of nitrogen. The cultivators co-operated by making available the manures necessary for the purpose and undertaking to apply the manures under the supervision of the extension staff. A total of 68 such demonstration plots were planted this year in both reserved and non-reserved areas. From the yield data obtained, the superiority of higher levels of manuring has become obvious. The average yields from control and treatment plots, are given below-(in tons per acre)

Local practice.	200 lb. N	250 lb. N	300 lb. N
42.1	46.5	49.3	57.0

The scarcity and relatively high cost of oil cakes as compared to ammonium sulphate is driving the cane growers to a more liberal use of ammonium sulphate to the partial or total exclusion of oil cakes. While experiments at the *Liaison* Farm have shown that the replacement, wholly or in part, of oil cakes by ammonium sulphate does not lower the yield, the question has to be examined carefully from the point of view of soil texture·

EARTHING UP AND PROPPING; HARVEST.

Lodging is fairly common in this area, particularly when the crop is well grown. As a means of preventing this, two methods are recommended. The first is to earth up the crop properly. All farmers earth up their crop, but the amount of soil raised is not sufficient and uniform as the work is done mainly by manual labour. To obviate this defect, earthing with a ridger is recommended and intensive propaganda in favour of the practice has resulted in an area of 1,725 acres being earthed up this way.

The other means of preventing lodging is to prop the cane. Trash twist method of propping, which has been found to be suitable to this locality is being popularised. The method was demonstrated on 18 private holdings, and a total area of 277 acres were propped up by this method.

Harvest:—Constant propaganda is being done to harvest the cane close to the soil, as this will not only increase cane and yields, but also produce a better crop of ratoon. The cultivators are alive to the importance of proper harvest and have been trying to follow the recommendations.

PLANT PROTECTION.

Diseases:—The most serious disease in this locality is smut. As a measure of prevention, ratooning was discouraged. In the absence of compulsive legislation,a certain proportion of the crop was ratooned inspite of advice to the contrary and smut made its appearance in a mild form. Insistent propaganda on rogueing the smut affected clumps was carried out and seed nurseries were periodically visited and rogued for smut An area of 1,380 acres including, plant cane, ratoon, and nursery plots were rogued for smut.

Insect pests:—The most serious pests in this area are the early shoot borer (*Argyria sticticraspis*) and top borer *Scirpophaga*. Early shoot borer was more in evidence in late planted crops and in ratoons. Earthing up of the young crop followed by irrigation was recommended.

RATOONS.

The main defect in ratooning in this area is that they leave long stubbles in havesting the plant crop. The correct method of ratooning by shaving down the stubble to ground level and the necessity for proper manuring of the ratoons was brought home to the cultivators by propaganda and demonstration. An area of 260 acres have been ratooned properly during the year. Ratoons here are liable to heavy infestations of smut and cultivators have been educated in the necessity of rogueng out all smut affected clumps.

Jaggery

More than half the total crop of sugar cane in this taluk is converted into *jaggery* and Hospet is one of the known *jaggery* markets of South India. The method of preparation of *jaggery* leaves much to be desired. The pans used are too large, and only single pan furnaces, without chimneys or proper ash pits are in use. Little attention is paid to clarification or scum removal, apart from the addition of a certain amount of lime powder to induce hardness. The quality of the *jaggery* in many cases is poor. Persistent propaganda is being done in favour of double pan furnaces, shallow pans and the proper use of clarifying agents and the necessity for greater cleanliness of the product. Three roller iron mills drawn by bullocks have come into general use. A total of 82 double pan furnaces were built by *jaggery* makers with the assistance of the development staff. 120 demonstrations in correct method of *jaggery* making were held. During the course of these demonstrations, data on extraction, Brix of juice and recovery of jaggery % cane were collected. An average extraction of 58% and recovery of 10% were recorded.

The importance of harvesting the cane between 11—12 months were stressed and the use of the Brix hydrometer to determine maturity was demonstrated. Advice with regard to time of harvest was followed by many progressive cane growers and over 660 acres were harvested at the proper time.

OTHER ACTIVITIES

Prize competition:—As part of the development work, an annual prize competition for the factory gate area is being organised. The total number of entries this year for the competition was 41. The highest yield this year is 70 tons 500 lb. and was achieved by Sri. Dommi Hanumanthappa of Hospet.

Yield Survey:—An yield survey of sugarcane in both the reserved and non reserved areas of the taluq is being carried out annually, according to an approved method by random harvest. This year a total of 97 plots were harvested. Taking both the reserved area and the *jaggery* area together, the average yield worked out to 34.91 tons.

Smut Survey:–As stated already smut is a serious problem in this taluq. A survey of the incidence of smut was carried out in selected villages, the observation being extended to both plant and ratoons. The relative incidence in Co. 419 and Co 449 were also compared. The results were as follows:—

	Percent infestation.	
	Plant cane.	*Ratoon*
Co.419.	1.27%	3.16%
Co.449.	Nil.	0.2%

These, in the main represent the activities of the development staff and the responses of the cane growing community to the suggestions and recommendations made by them. On the whole, their response has been encouraging.

DRY FARMING PRINCIPLES AND PRACTICES

By ALI HYDER, B.Sc., (Agri.)

Superintendent, A.R.S. Hagari

DRY FARMING PRINCIPLES

As a result of the introduction of the Dry Farming Research Scheme financed by the Imperial Council of Agricultural Research from 1934-43 the problems confronting the common cultivator were tackled on three broad principle.

I: Soil physics and meteorology.
II. Agronomy.
III. Crop Improvement.

Under soil Physics and meteorology the following items were studied.

STUDIES

(a) *Studies on soil moisture*:—Studies on the distribution of moisture in soils under field conditions in the different agronomic experiments were found to reveal that soils reach the maximum field capacity by the middle of October to a depth of 2′. The loss of moisture in the top 6″ layer of the soil is due to the evaporation from the soil surface. The moisture contents of the soils at the time of sowing has a decisive effect on the yields of the crops.

(b) *Studies on the surface runoff:*—The effect of having a cover crop of groundnut on the control of erosion was studied which resulted in the reduction of soil and water losses by nearly half when comparedto clean fallow plot. The water losses due to surface run-off was 45%, on the average of the total rainfall of twenty inches received annually. The losses were 6.5 tons per acre.

(c) *Physical and Chemical analysis of soil:*—The analysis of silt washed out reveals the loss of more plant nutrients than the top soils. The black cotton soils on account of their high colloidal status are sticky when wet and hard when dry. The shrinkage and wilting co-efficient are 65%. by volume and 18% respectively. Due to the shrinkage of soil, innumerable cracks develop which will have adverse effect on the crop growth, if the cracking occurs when the crop is tender.

(d) The meteorological work revealed the maximum average temperature being 102°F during April and May and 86 to 87°F from November to January and 90 to 100°F during the other months of the year. The minium temperature is 69 to 77°F from March to October and 65F to 63°F from November to February.

AGRONOMIC EXPERIMENTS

Under agronomic experiments, methods of soil and moisture conservation for a successful growth of crop in this tract of poor and precarious rainfall were tackled and a number conclusions drawn.

1. *Mechanical seed drill Vs country seed drill:*—Country seed drill was found to be more advantageous over the mechanical seed drill on the score of covering larger area in a shorter period.

II. *Sami Rao's Seed hopper-Vs-hand feeding in the local* gorru: The local hand feeding in the hopper is easier and better manipulation of seed exercised.

III. *Spacing of jola and cotton:*—13½″,15″,18″,21″,24″ and 27″ spacing were tried when 18″ spacing was found to be optimum for *jola* and 36″ spacing for cotton. This spacing was adopted to benefit the cultivator in utilising one country seed drill for sowing both cotton and *jola*.

IV. *Intercultivation:*—The crops *jola* and cotton depend on the desirability to create a suitable mulch of the soil. There is no binding regarding the number of intercultures.

V. *Deep ploughings*—Deep ploughing once in four years in the weedy fields was found to result in good yields.

VI. *Bund-former bunding*:— Bundformer bunding with 7″ bund was found to benefit the crop and resulted in extra income.

VII. *Manurial trials* :—With the several treatments conducted the cultivator is finally advised to manure his dry lands at 6 cart loads per acre once in three or four seasons.

DRY FARMING PRACTICES

With these principles of dry farming occular demonstrations in the *ryots*,holding were launched in the Dry Farming Development Research Scheme from 1943-48, by the generous grant of the Imperial Council of Agricultural Research. Temporary bunds with the bund forming implements which puts up ridges about 7″ high and dividing the field into compartents of ten cents each were widely tried in the *ryots*' fields and became an approved item of work. The cultivators themselves used the implements with their own cattle and men. The chief difficulty experienced is that the implement is too heavy for the small sized animals. The implement with one side blade was suggested to reduce the draught but this was not found suitable.

Spacing of crops:—The 18″ spacing of jola and 36″ for cotton which became popular with the *ryots* not only increased yields obtained but also more room for plants and gave moving space for implements between the rows of plants.

Adoption of improved strains:—Sorghum is sown in the month of October practically at the end of the rainy season. By this time the general prospects of the season would have been known to the *ryots*. If the rains received were good the cultivator took to the sowing of long duration type H.1. *jola* and in the deficient rainfall period he took to the sowing of the short duration variety M.4-73. *jola*.

Both H.1. and H.2 *navane* found favour with the cultivator and large areas under seed farms were arranged in several taluks of the district for multiplying the seed.

Manuring:—Manuring the land is a good dry farming practice but the limiting factor is its availability. Artificial manures are not beneficial for this tract of poor and precarious rainfall. As there is a paucity of cattle manure the ryots were advised not to waste the litter from the farm wastes and apply manure once in three or four years at 5 to 6 cart loads per acre.

Contour embankments:—The cultivators usually put up huge embankments at the toe of the field. This is ineffective; contour embankments provide the best form of distribution of rainwater in the field. For popularising the method to be adopted in the proper disposal of surplus water from the embanked fields with a view to minimise the adverse effects of standnig water, a contour bunding scheme was launched on the *ryots*' fields on a 50: 50 basis. The scheme was put into operation in 3 centres namely, Alur, Guntakal and Joladarasi.

Thus the results of this research were translated into practice in the *ryots*' holdings and this marked a substantial improvement. Still the manurial problems are to be taken up and the work is in progress in this direction.

A BRIEF REVIEW OF MILLET BREEDING WORK AT SIRUGUPPA

(WITH SPECIAL REFERENCE TO THE TUNGABHADRA PROJECT AREA)

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INTRODUCTION

Crop failures and consequent famines are very common in Ceded Districts because of the weak and erratic nature of the Monsoon in this tract. With a view to prevent crop failures and thus combat famine on a permanent footing, the waters of the Thungabhadra river have been harnessed to provide irrigation facilities for raisnig of crops successfully. In the low level canal zone, a total area of 2½ lakh * acres (composite Madras) are estimated to get the benefit of irrigation in the first instance. Of this, about 1,92,000 acres have been earmarked for dry-irrigated crops and the balance for wet crops. Among food crops, *jola* being the main staple diet of the working classes, occupies nearly half the area in the *ayacut*.

Preliminary trials at the Agricultural Research Station, Siruguppa, revealed that *jola* grows well under irrigation in the early season. i. e. *mungari* -from June to October, but it failed to yield remunerative return, when raised during the *Rabi* season. This season is locally called '*hingari*' and corresponds to October-February period. This is an important *jola* growing season of the black soils of this tract. The variety grown in dry lands is known as *Bilijola* (a white pearly grained variety), which is very much favoured by the cultivators for food in preference to the early sown *mungari* types of *jola* which are mostly yellow. An irrigated *hingari jola*, if included in the cropping calendar of the project *ryot*, helps not only in making the cropping pattern more scientific from the point of rotation, but also brings in more under food crops of the required quality and thus step up food production.

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*The Project *ayacut* as localised in the Taluks of Bellary, Siruguppa and Hospet that are now in Mysore State are as under.

Sl. No.	Taluk.	No. of villages getting benefit.	Irrigable Area in acres. Perennial zone.	Wet zone.	Dry cum wet zone.	Total.
1.	Bellary.	31	2,066.66	4.781.14	13,957.89	20,805.66
2.	Hospet.	10	5,061.50	867.25	3,457.98	9,386.68
3.	Siruguppa.	79	8,204.78	12,072.67	41,874-71	62,152.16
	Total.	120	15,332.94	17,721.06	59,290.58	92,344.50

In order to find out a suitable high yielding variety of *hingari jola* suitable for the irrigated black soils of the Tungabhadra Project area, a speicial Scheme styled "*Hingari jonna* Scheme" was launched in 1944.

WORK DONE IN THE SCHEME.

In the preliminary years, a few special agronomical experiments like "Time of Sowing" and "Time of irrigation", had to be conducted for the proper understanding of the breeding problems of irrigated *hingari jola* under the project conditions. Early sown (August) batches suffered from sugary disease resulting in poor grain yields. Late sown batches (October-November) had a severe attack by stem borer (*Chilo zonellus*). There was a significant decline in growth and yield with the progress of sowing dates. Results revealed that sowing during the middle of September gave the maximum yields. The data gathered from the irrigation experiment showed, that even with one extra irrigation especially during the earlier period of growth, the crop yields appreciated considerably. Irrigation at later stages of crop growth failed to improve the situation of the crop and behaved as good as the plot which did not receive any supplemetary irrigation. Systematic irrigation once a fortnight, at 2 acre inches depth, proved to be the best.

Studies on pests and diseases were also done in detail. The study during the crop grown in the early years revealed that one of the major causes for the failure of irrigated *hingari jola* was was mainly due to the ravages caused by pests and diseases in seedling, flowering and grain maturing stages of crop growth by shoot-borer flies (*Atherigona indica*) Shoot bugs- (*Pundaluoya simplicia*) Shoot borer moths (*Chilo zonellus*) and earhead bugs (*Calocoris angustatus*) respectively. Aphid and mites were also noticed in certain years. The crop also suffered from fungus and virus diseases like 'Rust' (*Puccina purpurea*), Sugary disease and speckle-yellow and stripe etc.

Among the pests, the most serious one that had to be reckoned with was the *jola* shoot-borer fly (*Atherigona indica*) The fly pest occured regularly every year in the seedling stage and caused seedling deaths in large numbers. The nature of damage and the life history of the fly were studied in detail. The flies attack the ten-day old seedlings. It was noticed that such of the plants that escaped the attack of the fly pest till the fifth week from the sowing date, were not affected later. The maggots attack the tender growing point, as a result of which the central shoot is killed, the growth is suppressed leading to *tussocks* and finally to poor stand and unremunerative yields. Among the large varietal collections that were tested, none proved completely immune to the fly pest. However, certain types from Bombay, Hyderabad, and Madras were found to tolerate the pest to a fair degree. Various methods of combating the fly pest were tried. Flooding treatments at different time intervals, with and without fish-oil-resin soap proved ineffective. Transplanting one month old seedlings to get over the fly menace was not of much advantage. The transplanting system being costlier then the normal drilling procedure, due to extra demand on water and labour, this remedy proved uneconomical. Application of heavy doses of manures and thereby inducing vigour in seedlings to withstand the fly menance better was of no avail. No doubt heavy manuring resulted in vigorous seedlings, but the manured plots in general, recorded higher fly incidence than the no manure plot. Possibly, more flies were attracted to the manures undergoing decomposition in the soil. The fly incidence was more marked in the plots manured with groundnut cake.

It is also likely, that the flies preferred vigorous plants to that of the week and lanky ones. Trials with insecticides like BHC and DDT were also done. Results revealed that spraying with BHC was found to be definitely effective. Large-scale trials with BHC are being conducted on the Station to work out the economics of the treatment. Adoption of higher seed rate and subsequent thinning of the unwanted plants resulted in a good stand and remunerative yields. Seed rate trials are under way to fix the optimum seed rate for irrigated *hingari jola* in black soils. *Calocoris* (earhead bug) when it appears in an epidemic form causes whole-sale damage. The nymphs suck the juice from the young developing grain. The attacked grains shrink and dry up resulting in chaffy ears. Of the various remedies tried to combat the pest, spraying DD↿ (Guesarol-550) of 5% strength as a prophylactic measure in the flag-leaf-stage was found to destroy all the adults lurking in the jola leaf spindles and thus prevent oviposition and further multiplication. A second round of spraying the affected patches, if any, completely checked *Calocoris* damage. Among other non- insect pests, birds as a class had to be reckoned as serious pests, which peck and eat the young developing grains, leaving the ears chaffy. Except scaring by manual labour, so far no cheap and effective remedy is known to combat bird menace.

Damage by rust was conditioned mostly on the time of incidence of the disease. Rust appearing in pre-flowering stage was found to be more dangerous than at the grain formation stage of crop growth. In the former case, the crop failed to put forth any ears; while in the latter only the quality and outturn of straw were affected. Early sown crops (August plantings) suffered badly from sugary disease. Due to the disease, the yong fertilised florets failed to set seed; but instead, a thick pastelike sugary fluid oozed out. Sugary disease was easily got over by adjusting the sowing time. Batches sown in mid-September and later were free from the sugary disease. The shoot-bugs (*Pundaluca simplicia*) acted as insect vectors and brought in the virus disease— 'Speckle-yellow' and stripe locally called as the yellow leaf disease. This led to the yellowing and drying up of the leaves, reduction in the size of earheads, and non-setting of grains. Even mortality of plants was noted in extreme cases.

A world collection of sorghum varieties of varied genetic stock were grown at Siruguppa, to study their adaptability to the project conditions. These collections included types from seventeen countries outside the Indian Union, ten States within India and from eleven Sorghum growing districts of (composite) Madras State. The types were put to vigorous tests and a thorough search was made to spot varieties suited to the project conditions and which combined yield with resistance to pests and diseases that are commonly met with, in this area. Results showed that exotic types were not, as a rule, suited to this tract. They were mostly low yielders and succumbed to pests and diseases. The types from Northern India also did not fare well. Promising cultures could be secured only from the South Indian varieties hailing from Bombay, Hyderabad and Madras Deccan. Seven outstanding selections culled out of the material were passed through various stages of yield trials for five seasons. Their yield performance in comparison with the local (H.1) which is usually grown in this tract as a dry crop, is presented in Table I

It is seen from the yield figures that the average grain yield of rainfed crop was only 266 lb. per acre, while the yields of the selections raised under irrigation ranged from 1,587 lb to 2,078 lb. per acre, which is six to eight times that of the rainfed crops. With regard to straw yields, the increased yields obtained under irrigation is nearly fourfold.

The improved selections could not be tested in ryot's holdings, under irrigated conditions, as Tungabhadra water was not made avaiable. Now that the water has been let in for use by the *ryots* extensive trials in the districts have been planned during the year 1954-55.

During the studies, it was observed that the best grain yielders did not register good straw outturn. The highest straw yielders did not record sufficiently high grain yields. Sorghum straw is very important in the agricultural economy of this tract. Attempts were therefore made to combine high grain yields with high straw yields by resorting to hybridization between the two categories of the types on hand. At present, the hybrid progenies are under various generations of study. The special Scheme launched in 1944 came to a successful conclusion in September 1952, with definite results that could be advocated to the project *ryot* The work is now being continued as a part of the normal activities of the Agricultural Research Station, Siruguppa, with a view to evolve still better types of *Hingari jola* for cultivation.

SUMMARY OF RESULTS ACHIEVED SO FAR

The outstanding results achieved are: (1) One of the main factors which reduce the yield of irrigated *hingari jola* in this area, is the attack by insect pests that occur on the crops. The most important of them are the shoot-borer fly and the earhead-bug. The fly pest attacks the seedlings in the very early stages. The fly damage can be reduced by (a) spraying with BHC. and (b) by the adoption of a higher seed rate, which gives a greater chance for survivals and ensures good stand resulting in remunerative yields. With regard to the earhead-bug, spraying with DDT. (Guesarol 550) checked the pest effectively. (2) The optimum time for sowing *hingari jola* under irrigation was found to be the middle of September, as against the October sowings in the rainfed lands. (3) The pick of the selections that could be grown under irrigated conditions, during the *hingari* season are (i) M. 31–2; (ii) M. 9. S–1–2 and (iii) M. 47–3. By adopting the above mentioned measures, it will be possible to raise successful and remunerative crops of *Hingari jola*, in the black soils of Thungabhadra project area and obtain nearly 2,000 lb of grain and 4,000 lb of straw per acre.

Navane-(*Setaria italica*) is also one of the millets largely grown in this tract. Ragi *(Eleusine coracana)*, is not at present raised in this area due to the low and erratic nature of the rainfall. For successful cultivation of ragi crops more rainfall is required than that of other millets. Barring the Tinnevelly District, *Cumbu (Pennisetum typhoides)*[1] is mainly confined to red and light soils, situated in low rainfall zones. Nearly eighty percent of the Tungabhadra Project area comprises of heavy black soils. Hence *Cumbu* has not been included in the croppng pattern of the project *ayacut*. Intensive breeding trials have not been done in *mungari jola* and other millets (viz., *Navane* and ragi) so far. Therefore, breeding work on these have been taken up only during 1953–54, with a view to evolove suitable strains of millets for the project area. It is too early to have a final say on them now, excepting to indicate that the prospects of introducing these crops in the Thungabhadra Project *ayacut* are very bright. Research problems pertaining to the areas not served by the project area are being tackled at the Agricultural Research Station, Hagari.

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TABLE

IRRIGATED *Hingari Jola* Types

Sl. No.	Selections. Years.		1	2	3	4	5	6	7	8	Rainfed yields for comparison.
			Acre yields in pounds under irrigation.								H-1
1.	1947-48	Grain.	1640	1488	1441	1378	1391	1210	1658	1188	162
		Straw	2715	3702	3412	3527	2488	5082	4395	3589	1150
2.	1948-49	Grain.	1629	1369	1636	1356	1411	1502	1469	1364	137
		Straw.	7793	7046	5172	6511	7394	7037	7159	7155	2179
3.	1949-50	Grain.	3502	3434	3421	2917	2027	2642	2760	2557	576
		Straw.	4388	4395	3742	4657	3860	4125	5886	3371	2216
4.	1950-51	Grain.	2049	2528	2151	2367	2398	2428	1939	2030	398
		Straw.	3151	3248	4286	3793	3250	3884	3451	3173	1517
5.	1951-52	Grain.	1568	1247	1216	1576	1449	640	569	794	57
		Straw.	3299	3389	3178	2957	3816	3805	4044	3854	1190
Average for 5 years		Grain.	2078	2013	1973	1919	1735	1684	1679	1587	266
		Straw.	4269	4356	3958	4289	4162	4787	4987	4228	1650

SELECTIONS.

Note:—

1. M. 31-2.
2. M. 9. S-1-2.
3. M. 47-3.
4. M. 35-1.
5. P. B. 2. R.
6. N. D. 15.
7. H. 1. - (control)
8. P. B. 3. R.

A REVIEW OF COTTON WORK IN BELLARY DISTRICT

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INTRODUCTION

Cotton is one of the main commercial crops of South India. The cotton area in of the Ceded Districts constitutes nearly forty percent of the total area of the composite Madras State. Among the Ceded Districts, in Bellary District alone*, nearly six lakh acres are grown to cotton every year. With the advent of the new Andhra State and the consequent merger of the seven taluks of Bellary with Mysore State, as much as fifty percent of the cotton area (i.e., three lakh acres) has been added on to Mysore State. Thus, it is seen that the cotton acreage in Mysore has reached a phenomenal figure of 4¼ lakh acres.

A present, "Westerns" (mainly *G. Herbaceum* var *acerifolum)* and "*mungari*" (mainly *G. Arboreum* variety *neglectum* forma *bengalense*) are being grown in Bellary District. The first type is mostly confined to the black soils and the other to the red and light black soils. The Westerns have low acre yields and the ginning outturn is also poor. *Mungari* has the defect of being very short stapled. The entire crop is being raised under rainfed conditions.

Famine is almost a regular feature in this tract and to prevent the recurrence of this phenomenon, the waters of the Thungabhadra river have been harnessed, for providing irrigation facilities and thereby prevent crop failures. An area of about 2½ lakh acres (in composite Madras State) have been proposed to be brought under irrigation in the first instance. Of this, 92,344 acres have been localised in the taluks of Bellary, Hospet and Siruguppa, now merged with Mysore. Soil survey report (P. V. Ramaiah-1937) revealed that 80% of the project *ayacut* comprises of black soils and cotton figures as one of the major crops in the cropping scheme of the tract. Nearly half a lakh of acres (area localised in Mysore State) are expected to be grown to cotton every year, under irrigation. Replacement of the existing rainfed indigenous cotton by the more renumerative and quality *hirsutums* has been attempted in the project *ayacut*. This will not only bring in higher monetary returns to the cotton growers but also helps in reducing the imports of long stapled

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**COTTON AREA AND LINT PRODUCTION IN WESTERNS' TRACT*

(EXTRACT FROM SEASON & CROP REPORT FOR 1950)

Sl. No.	District.	Area in acres.			Lint production in bales of 400 lbs each.
		Un-irrigated,	Irrigated.	Total.	
1.	Bellary.	5,89,249	1634	5,90,883	83,660
2.	Anantapur.	1,20,334	—	1,20,334	17,130
3.	Cuddapah.	41,397	656	42,053	6,600
4.	Kurnool.	1,65,522	—	1,65,522	24,700
	Total.	9,16,502	2,290	9,18,792	1,32,090

Different Varieties of Cotton Grown in this Tract and its Production.

Westerns'.	1,13,370 bales.
White and RedNortherns	18,720 bales.
Total-	1,32,090 bales.

cotton from outside countries like Egypt, Sudan and U.S.A. American Uplands are therefore chosen for the Project area in preference to the Asiatics.

STUDIES ON LONG STAPLE COTTONS

Preliminary trials at Siruguppa revealed that as a *Kharif* crop, the Uplands suffered from red-leaf and late maturity. The yields were also generally poor, due to heavy shedding with a large proportion of bad *kapas* content. It was noted that the uplands were better suited to the *Rabi* season than for the *Kharif* season. It was also observed that the incidence of pests (Thrips & Jassids) and diseases (Blackarm) were a regular feature of the Americans when the Uplands were raised as an irrigated *Rabi* crop. These factors coming into play adversely affected the growth, yield and quality of the produce. Generally, the American uplands are less hardy than the Asiatics with regard to their resistance to adverse seasonal conditions and pests and diseases. Breeding work on the American cottons was started in the year 1945, with the financial assistance of the Indian Central Cotton Committee, Bombay. Trials were conducted for irrigated conditions at Siruguppa and at Hagari for rainfed lands. The work done in the Scheme and the outstanding results achieved so far, are summarised in the following paragraphs.

All over the world, the success or otherwise of a cotton crop depends on the incidence of pests and diseases. In India, Jassids seems to be one of the major deciding factors, for the succesful introduction of American cottons. Ramanathan (1946) attributed the failure of the East India Company to introduce the American cottons in India, to the ravages caused by the Jassids. Varma and Afzal (1940) made a similar remark that in Punjab, Jassids were the chief obstacles for the successful cultivation of superior cottons. In Sind, Madras and in other areas, where American cottons are grown, the plight of uplands had not been different and the performance of these at Siruguppa was not an exception to this rule. With the introduction of an irrigated cotton, Blackarm disease became common in this area. Though the incidence of Blackarm is largely influenced by the environmental factors, the spread of the disease within the organism is more of a genetic nature. Thus, breeding of Jassid and Blackarm resistant types became an important problem for the succesful introduction of Uplands in the Project area. This problem was takled in two ways viz., (i) by resorting to remedial measures to check the pests and diseases effectively by the application of insecticides and fungicides, and (ii) by resorting to the breeding of a resistant variety to withstand Jassids and Blackarm. Investigations showed that it was possible to protect the crop against pests like thrips and Jassids with the aid of insecticides like DDT or BHC. It was found that primary infection of Blackarm could be checked to a certain extent by resorting to seed treatment with either Agrosan G.N. or Perenox. The use of pesticides and fungicides indicated that they can be regarded only as palliatives but not as a complete solution to these problems. The only best way is to evolve varieties resistant to pests and diseases under varied conditions of soil-variety-climate-complex. Attempts made in this branch of study have been crowned with success. Two cultures viz., 1821-1-1 and 2196-4 isolated at Siruguppa, proved to be resistant to Jassids and Blackarm respectively. It was observed that fresh introductions of reputed resistant strains have failed under Siruguppa conditions. The experience of other workers in this field (i.e. Dr. R.L. Knight-Sudan) have clearly indicated that the development of resistance to different eco-climatic conditions have to be tackled separately for the different zones. Presumably, this is necessary due to the existence of varied species and strains of pests and diseases respectively. It is gratifying to record here, that fortunately, culture 1821-1-1 and 2196-4 (isolated at Siruguppa) were found to be highly resistant to Jassids and Blackarm respectively under varied conditions of soil and seasons. Especially, 2196-4 was found to maintain its resistance state to Blackarm disease, even under Sudan conditions. Since, co-existence of two varieties in the same tract is not desirable attempts are being made to combine the two resistant characters (viz., for Jassids and Blackram) in one and the same strain. With this end in view, crosses were synthesised with 1821-1-1 and 2196-4 and the hybrid progenies have shown improvements in the desired direction. 14 x 6, (a type from Greece) has been found to be resistant to thrips. Crosses between 14 x 6 and the promising cultures on hand have been effected and the progenies are under study.

A large number of collections from the different states in the Indian Union and from abroad were tested under irrigated conditions at Siruguppa and in rainfed lands at Hagari. In the earlier years, H.A.11, was found to possess many desirable characters and also showed great flexibility of response to varying seasonal conditions. Small improvements in ginning and staple were recorded by resorting to reselection in the promising bulks like H.A.11, Parbhani American, Latur types, M.A.2, Laxmi etc.; but the quality of the produce remained the same. Many new exotic types were tested at Siruguppa without much success. Egyptian types (like Malaki, Zagora and Giza), Central American collections (like Mesilla acala, Deltapine, Cocker and Stoneville), Empire cotton and 14 x 6 (of Greek origin) were tested under irrigation, at Siruguppa. They all suffered severely from red-leaf, thrips, jassids, and blackarm. Heavy shedding of leaves and flower buds were noted. They were very poor in productivity. The boll opening was defective and the quality of the produce gathered was also poor. Prolific bulks like H.A.11, M.A.2, Laxmi and Surat Backrosses showed high variability and reselections made from these have yielded encouraging results. Low fibre maturity is one of the problems met with at Siruguppa. Reselections from Gadag crosses were found to be desirable from the point of maturity. Further work in this direction is still underway.

In the unirrigated trials, the upland varieties responded well to early plantings in August. Thrips, jassids, blackarm and bad *kapas* content were also found to be serious, in rainfed lands at Hagari as well. A number of selections yielded kapas as much as *deshi* cotton-(W.1). All of them possessed staple length and ginning outturn superior to the *deshi* cotton. M.A.2 and Laxmi, reselections like 320, 650, 576-3 etc., hold out much promise. Trials conducted with M.A.2 and Laxmi in the cultivators' fields (Bellary District), under rainfed conditions, have given encouraging results. It was observed that the Upland types have recorded seed cotton yields ranging from 200 to 300 lb per acre, under varied conditions of season and soil. Laxmi being a quality type, also fetched a premium in the market over the *deshi* locals.

STUDIES ON MEDIUM STAPLE COTTON

Even with the advent of the Thungabhadra Project, large areas of land will still have to depend on the monsoons. To serve the needs of the area not served by the Project, improvement work on '*deshi*' cottons has been tackled at Hagari. Concurrently, attempts are also being made to replace '*deshi*' types with Uplands as far as possible, in localities having favourable rainfall and climatic conditions. The experience has shown that uplands like M.A.2 and Laxmi come up well, in areas where the rainfall is slighly heavy and the season is early. The rainfed '*deshi*' cotton that is largely grown in the black soils of Bellary, comes under the trade classification of 'Westerns'. The variety grown in the Westerns' tract is a medium staple warp quality of *herbaceum* cotton. The tract is subject to frequent visitations of famine, due to deficit and erratic rains. Consequently, the quality of cotton is poor and also highly variable.

To evolve a suitable cotton biotype for the Westerns area, breeding work was started as early as 1906, at the Agricultural Research Station, Hagari. The strain H. 25 was isolated in the earlier years at Hagari. Westerns-1 cotton, which is now under large-scale distribution was also evolved at Hagari. Westerns-1 (the old name being Hagari-1) is under general cultivation since 1930. It was evolved by pure line selection. This marked a substantial improvement over both "*Jawari*" cotton (unselcted local bulk) and the previous strain-H.25, in the matter of quality and ginning outturn.

However, W.1. cotton continued to suffer in years of deficient rainfall and recorded low yields. Fall in staple length and increased wastage in the processing stages was also noted. There have also been complaints from the traders in the recent times, about the deterioration of the W.1 cotton in quality (i.e., bulk of W.1 raised in the 'Westerns' zone seldom reached the basic staple of 13/16 inch, fixed for the Westerns cotton, under the Indian Cotton Contract). Hence, it was found necessary to undertake intensive breeding trials for improving the Westerns cotton. A Scheme was launched at Hagari, in the year 1949, with the financial assistance of the Indian Central Cotton Committee, Bombay, for the improvement of the Westerns-1 cotton.

A wide collection *herbaceum* of varieties of varied origin, including types from abroad were tested at Hagari. The new introductions as such were found to be unsuitable for the arid black soils of Hagari. Some of the Bombay types (Jayawant etc.,) though late in habit, were high ginners with superior staple. A large number of crosses were synthesised, using the choice parents. The work in the Scheme consisted mostly of study of hybrid progenies. The observations showed that the hybrid progenies are superior to W.1 in one or more characters. The improvement in ginning outturn was up to 6% over that of the control and in staple, the increase noted was upto 3 mm. Selections like 4136, 4287 and 4327 have registered encouraging results, under bulk yield trials on the Station. Cultures 2-3-68 and 2-3-69 have fared well in cultivators' fields. These possessed good ginning outturn combined with the staple and yield of W.1, the control. *Arboreum* varieties of repute, received from other research stations were tested at Hagari for three seasons. The results proved disappointing and hence further trials with *arboreums* at Hagari were discontinued. Further work in the Scheme is still in progress.

STUDIES ON SHORT STAPLE COTTONS

The inferior *Mungari* (mainly *G. arboreum* race *bengalense*) is usually grown in red as well as light black soils. The problem of improvement of *mungari* cotton was being tackled at Adoni (now in Andhra State). Strain 881 F (Rayalaseema-1) evolved in the *Mungari* Cotton Improvement Scheme, has been found to be superior to the local *mungari*, in more than one character. It has also been reported to have done well in cultivators' holdings, in the last two seasons. In 1952, a new *mungari* strain from Madhya-Pradesh *viz* H. 420, was introduced in Bellary district and this strain by virture of it's earliness, high yield and fineness has already gained much popularity in this tract. Plans are under way, to multiply H. 420 seed under seed farm conditions, for general distribution.

JOLA CULTIVATION IN BELLARY DISTRICT.

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Jola is the important staple food crop of this district, grown in about 6,00,000 acres: There are two main seasons for sowing, popularly known as *mungari* and *hingari* seasons. The former is sown in June.–July in light soils with the help of South west *monsoon* rains; while the latter is sown in September-October season in heavy clay soils, taking advantage of North east *monsoon*. The district records more rains in September–October and in the heavy clay soils the rains of South west monsoon are not sufficient to wet the soil to sufficient depth for successful cropping of *Jola*. So the *ryots* work the *guntaka* after each rain from June to August to preserve moisture in the clay soils and *Bile Jola i.e.* white variety is sown in September–October rains. This will come up well with the help of subsoil moisture and North east monsoon rains giving about 400 lb. grain per acre. The yield depends upon the rains received during South west and North east monsoons and manuring. Since the sowings are done in late season, the *ryot* can easily judge the total rainfall received during south west monsoon and if sufficient normal fall is received, he can sow long duration *Bile Jola* which gives very good yields in the years of heavy rains and short duration variety is recommended if sufficient rains are not received during early season. H.1 *Jola* of long duration is the recommended strain for this district for late season sowings; while M–47–3 is the short duration strain recommended for the same late season. The *ryot* can select any of these two strains depending upon the amount of rainfall received in early season. H. 1 strain takes about 15 days more than M–47–3 (Bombay strain) and gives more yield of straw. In grain yield performance both the strains give about the same yield. Fodder is also an important factor as this is the main source of supply for cattle of this tract. In years of low rainfall, long duration type H.1 may not give satisfactory performance while short duration M–47–3 will give better performance. For early season local yellow *Jola* (*Pacha Jola*) and Co.9 Strain (white *jola*) can be sown for June–July sowings.

The cultivaton and manurial practices are given below. Only shallow tilth is given by working *guntaka* two to three times at intervals. Manuing is done once in 3 to 4 years, at about 5 tons per acre. Cattle manure is not available in large quantities for applying in the extensive dry lands of this region. Normally there will be a pair of work cattle for every 30 acres of dry land. About 12 tons of farm yard manure can be prepared annually from a pair and just sufficient for about 3 acres. Sheep penning is also commonly done at about 3,000 sheep per acre. The manure is covered either by working country plough or *guntaka*. When the field is brought to tilth, *jola* is drilled at 3 to 4 lb. seed per acre, with a distance of about 18″ between the lines. The *ryot* is not very anxious to have a higher population of plants in dry lands, as moisture is a limiting factor; hence a thin seed rate is adopted in early season. For late season, 5 to 6 lb seed rate is advised, as the attack of fly maggot (*Atherigona indica*) is very severe and attacked seedlings have to be thinned out during 4th week. Interculture consists of working *danthies* in between the lines to check the weeds and to create mulch to preserve moisture. Finally the crop is harvestod.

In dry land cultivation, successful cropping is not assured, due to uncertainity and ill distribution of rainfall. On account of frequent failure of crops, famine conditions are very common in these parts. Govermnent used to spend large sums to give relief to the cultivators. To check this chronic famine, after long consideration and thought, Tungabhadra Project was launched, to raise assured crops under irrigation when rains fail. The project commenced to work in 1945 and water was allowed in channels for regular irrigation from February–March '54. Under project conditions, one need not wait for rains and he can sow the crop in the right season. Thus *mungari jola* can be sown in June-July. With the summer showers of May–June, the land can be brought to tilth by working the plough. Deep ploughing is essential under irrigated conditions. After ploughing, cattle manure or compost should be applied at 5 tons per acre and again covered with country plough. The bund former is to be worked suitably to lay temporary bunds at 6·6″ apart. The bunds have to be rectified at ends by manual labour with a *mummaoty*[1] *Guntaka* is to be passed to level the beds in between the bunds formed. Then chemical manures consisting of ammonium sulphate and super phosphate are to be applied in *akkadies* tied to a *gorru* in 6 lines with 11″ apart between the lines. The manure is again covered with *guntaka*. This placement method of application of fertilizers give better yields. Manuring just prior to sowing is recommended, as there will be enough labour available in the early cropping season. Top dressing of fertilizers when adopted, gets delayed some times, due to wet weather that prevails during growing period and non availability of enough labour. The manure in this case is broadcasted between the lines and *danthies* are worked to cover it. Experiments conducted else where, clearly indicated higher response of crops to manures applied by placement method. Similar experiments are in progress in this Station, to test the time and method of application of fertilizers on *jola* crop. Manurial experiments conducted at this Station revealed, that irrigation alone with out manuring and manuring alone without irrigation had not appreciated the crop yields of *jola*. Under both manuring and irrigation, excellent crop yields are obtained. Manurial dose of 40 lb. P and 40 lb. N in the form of superophosphate and ammonium sulphate is the recommended mixture for *jola* crop.

After manuring, Co.9 *jola* seeds of 95% viability, are drilled in *gorru* of 6 tynes which are 11″ apart. The seed drill will conveniently pass between the bunds formed already. Then again *guntaka* is passed to cover the seeds sown. The double mould board plough is worked at convenient distances to form irrigation channels, which require rectification at ends by manual labour.

One important point to be remembered and observed is to work the bund former along the contours and irrigation channels in the slopes, at a distance of about 6 to 8 yards, depending upon the gradient or slope; shorter spacing being adopted with higher slopes Each such small bed formed by the bund former and ridge plough, may measure about ¼ to ½ cent in area. The slope and experience will decide the size of bed. Since bed system of irrigation for cereals and furrow system of irrigation for cotton and sugarcane, are recommended for the project, no large scale levelling with bull dozer is required. Such levelling will bring forth sub-soil and salts to the top. No good crops can be raised for some seasons till soil fertlity is built up. Where there are big mounds,levelling is unavoidable in patches; buck scraper (bullock drawn implement) can be used for this purpose.

After sowing of *jola*, irrigation should be given for the seeds to germinate. Generally 2″ of irrigation once in 15 days interval is recommended. If rains are received, then irrigation should be adjusted accordingly. When the crop is about 4 to 5 weeks old, *danthies* should be worked in between the lines of *jola* in the beds to check weeds. H.M. *guntaka* No. o is recommended. Three such *guntakas* can be worked together at a time with pair of bullocks, using long yoke. The crop will thus receive one interculture and about 2 to 3 irrigations during growing period in addition to rains that would be received in the season. The *jola* crop will come to harvest in October–November. The duration of Co.9 *jola* is about 105 to 110 days. The *ryot* is advised to plough the lands after harvest of paddy; remove the stubbles and raise a green manure crop of sunnhemp for incorporating the same in the soil. Water is given free of water cess in Tungabhadra Project *ayacut* for green and fodder crops and *ryots* should avail this concession to build soil fertility.

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[1] Hand spade

At the agricultural Research Station, Siruguppa, *Jola* Co.9 strain in *mungari* season under irrigation and manuring had yielded 2,500 lb. grain (about 12 pallas) per acre; as against 2 to 3 pallas of grain yield in dry lands in normal years of rainfall. The fodder yield also is correspondingly more. Irrigated *Jola* had recorded 6,000 lb., straw yield per acre; as against 1,000 lb. straw yield from rainfed crops. The yields are increased by about four times in the project *ayacut* due to proper manuring, timely sowings and irrigations. The *ryot* should realise this advantage. *Hingari jola* is not recommended in the Tungabhadra Project; as the crop yield is generally low (about half of *mungari* yields) in the late season crop and again the attack of fly maggot is severe on the seedlings, mortality of which is very high, amounting to about 80% attack. The project *ayacutdar* is therefore advised to raise *mungari jola* in preference to *hingari*. If a ryot still wants *hingari Jola* then he is advised to grow M–31–2 strain (Bombay type) which comes up well. Co.9 *jola* should not be sown in late season, as it suffers badly from fly maggot attack.

For more details please contact the local agricultural officers. *Ryots* are requested to pay a visit to the Agricultural Research Station, Siruguppa to witness the crops and implements recommended. The staff will only be too glad to receive them, showing the various crops, agricultural operations, implements; lay out of the land by terracing and running irrigation channels suitably to irrigate each field measuring about 40 to 50 cents; green manuring practices to improve the soil fertility.

A NOTE ON THE CULTIVATION OF ONIONS IN THE BELLARY DISTRICT

C. M. REVANNA, B.Sc., (Hons.) District Agricultural Officer

(*Allium Cepa L.*) Liliaceae. ORIGIN AND AREA.

Onion has been grown from time immemorial and probably originated from Western Asia. It is a biennial crop grown as an annual although some form as Tree Onion or Egyptian Onion are perennial. In the Bellary district the biennial type known as the 'Bellary Onion' that gives a single bulb is grown nearly on two to two and a half thousand acres annually. (In 1951-52—2,274 acres). Thus this district is famous for onion and its seed production, marketing and export.

IMPORTANCE

Onion is used as a salad and culinary vegetable and also, as a condiment for garnishing and preparing chutney etc. It is one of the important irrigated profitable garden crops in this district which can be dried properly and stored nearly for two months without deterioration, unlike most other vegetables. Garg is of the opinion that all the vegetables fall in the group of protective foods that supply the human body with sufficient vitamins and minerals, which are very essential in a balanced diet which are too low in the cereals. He further writes that in India the production fo vegetables is very low, considering the requirements of the population at 10 oz. *per capita* per day, as recommended by the nutritional experts, and says that atleast seven to ten times increase in production is very essential to meet the requirements. The rich source of Vitamin. C. and sulphur to maintain our health and the highly bactericidal qualities that protect us from many bacterial diseases, the possibility of storing and export for a longer period to distant places without deterioration and the ease of seed production and decent profits demand the attention of the growers, consumers and also the research workers for effecting allround improvement regarding the method of cultivation, controlling pests and diseases, marketing, transport and then finally by increasing area under onions in suitable places like Bellary District and other areas of the State as Kadur, Hassan etc.

CLIMATE

Though the onion crop is highly cosmopolitan and adaptable to areas with a great range of temperature (66°F—115°F) and elevation (sea level to 6,000 ft.), it does not stand more than 30″ of rainfall during the growing period. Bellary district is highly congenial with regard to temperature, rainfall etc., to raise two crops of onions in a year, under irrigation conditions.

VARIETIES

There are two main groups with sub groups or varieties, under each. The Bellary Onion is a single bulbed, big sized variety with bulbs ranging from 1 to 2″ in diameter and with either light pink or white colour. The pink or red variety has a mild flavour, a trace of pungency, and sweet taste. The white variety is comparitively flat and insipid. The onion grown in the eastern parts of Bellary is red in colour and as one goes westward one finds that the white is tending to preponderate over the red variety. The country onion with number of small bulbs is not commonly grown in this district.

SOIL

Usually onions are grown in loamy 'friable' well drained soils under irrigated conditions. But onion is also grown as a dry crop in the highly retentive black soils in certain areas in this district in years of good and properly distributed rainfall

SEASONS

The crop can be grown all through the year though the bulk of the sowings or plantings are done in (1) June—July and (2) December—January by sowing seeds directly or by planting seedlings mainly.

NURSERY

To raise seedlings to suffice for planting an acre, about four cents area is worked up well to create good tilth. Then beds of 10′ x 3′ are made and manured heavily. About 4 to 5 lb of seeds are sown and watered (by rose can in the early stages) with gentle flow of water over the sown beds. Later, regular irrigation, and weeding are attended to. In about 5 to 6 weeks seedlings will be ready for transplanting with 6″ of height normally. Just a a day previous to pulling out for transplanting in the main field, the beds are well irrigated to facilitate pulling.

CULTIVATION

Preparation of Mainfield:—The field is ploughed four times to create good tilth. Just before the last ploughing 25 to 30 cartloads (12 to 15 tons) farm yard manure or compost is spread and mixed in the soil. Further, it is found that the addition of sufficient ash or manure helps for the longer preservation of onions after the harvest. Then the land is thrown into ridges and furrows with the help of a ridger with 15″ to 24″ between the rows depending upon the soil fertility.

Transplanting:—The seedlings are planted on both the sides of the furrows with 5 to 6″ spacing in singles after letting water in the furrow.

After Cultivation:—The crop is irrigated once in five days during the first month and once a week later. The first hoeing is done about the 25th day after planting and later two or three hoeings are given once a fortnight.

Since the monsoon crop is too luxuriant the plants are trampled down lightly with the foot when the land is dry. The plant reassumes the erect posture in 3–4 days. This arrests growth to some extent. The trampling is done upto three times when the crop is very luxuriant. The hot weather crop is not luxuriant and is not given this treatment.

The bulbs begin to form usually three months after planting and are visible outside and are not earthed up or covered with soil. Then the flower heads are gathered before they open and sold for use as vegetables. Even when the flower heads are not required, they should be pulled out, as otherwise, the formation of the bulb is interfered with.

HARVESTING AND YIELDS

In about four months after planting the crop will be ready for harvest when the leaves turn lightly yellow and begin to lodge indicating the maturity of the bulbs. Then the bulbs will be well filled and the outer layer of the skin will be dry and peel off easily. The crop is irrigated 2 or 3 days before the harvest to soften the soil, it it is necessary, to pull the bulbs. Then the leaves are removed with knives after 2 to 3 days and the bulbs spread in shade where there is a free circulation of air. After a fortnight, most of the *ryots* put them in small heaps of 3 to 4 feet width and height in the fields in the thatched places which are rainproof but allow free movement of air. Thus without any fear of deterioration or rotting, onions are stored for months together.

Depending upon the care and the intensity of cultivation, manuring, season, attack of pests and diseases etc., an acre yield of 8 to 15 thousand pounds of bulbs is usually harvested. Even 20,000 lb. yield is not uncommon.

SEED COLLECTION

The Bellary onion bulbs obtained from the summer crop are held in storage and planted in October–November, at one foot apart, on one side of the ridges, formed 1½ feet apart. The inflorescence produced is allowed to develop into seed. The heads are gathered when the thin papery capsule enclosing the seed is partially dry, in stages, and then later dried and seeds separated by trailing. Thus about 250 to 300 lb. of seeds are got from an acre which usually find ready market. Since the onion seeds lose their viability in the course of an year, it is very essential to sell the fresh seed and to see that the sale or mixing of old seeds is put an end to. Further some merchants mix the straw seeds got from the ratoon allowed when the prices for bulbs are too low. Further the inflorescenece forming in a seedling planted crop also set and produce seeds, if allowed. But all these seeds give rise to seedlings that yield poor bulbs.

MARKETING

Both the bulbs and the seeds are sent to various places in Andhra and residuary Madras State mainly.

Bulbs:—The peak periods for onion market in the district are (1) April to June and (2) December to March, when the business and export will be in full swing mainly from Bellary, Hospet and Kottur railway stations. The merchants are experiencing great difficulties in finding facilities for export by train which is 1/3 to 1/2 that paid for lorry transport. The middle men are taking commission both from the growers and from the purchasers which can be avoided by establishing cooperative purchase cum sale societies. The market fluctuation for the year 1953 is as follows in Bellary.

Months	April	May	June	December	January	February	March
Cost of bulbs per maund of 26 lb.	5-10-0	5-8-0	8-0-0	5-10-0	5-8-0	4-12-0	4-12-0

By providing proper storage and marketing facilities the stabilisation of prices can be attained to some extent.

Seeds:—Even here, to avoid middle men and to supply growers fresh viable pure seed, certification and cooperative marketing are very essential. There are three types of seeds with the given prices, locally, based on the place of collection of the same.

Seeds	Rate per seer (about 1½ lbs. to 1¾ lbs.) of seed.
1) Rampur or Bellary onion seed,	Rs. 6/–to Rs. 8/–
2) Gulbarga onion seed.	Rs. 3/–to Rs. 5/–
3) Balichakravarthi onion seed.	Rs. 4/–to Rs. 6/–

Annually about five hundred bags of seeds measuring 100 seers are handled in this district which amounts to Rs. 2,00,000/–nearly in addition to that of bulbs.

PESTS AND DISEASES

Onion thrips and *Alternaria* are common which are controlled by spraying Gammexane P. 520. (at one ounce in one gallon) and one per. cent Bordeaux mixture respectively.

METEOROLOGY & AGRICULTURE.

By S. P. VENKITESHWARAN, B. A. (Hons.),
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In India, with her enromous population, the problem of food production is of vital importance. The farmer, through the ages, has ever prayed to the "rain goods" to shower timely and plentiful rains for his crops. He looks forward to a timely monsoon and a good distribution of rainfall during the year. We may recall a Finance Member's declaration that the Indian Budget is a gamble on the monsoon rainfall.

One who examines the past records, particularly of the last 75 years, for which reliable information is available, cannot help noticing that in many years, parts of the country have been subject to famine owing to failure of the rains and that occasionally, the entire country has had to suffer this calamity. In recent history, the years 1877, 1899 and 1918 will long be remembered as disastrous famine years due to the failure of the monsoon rains.

The healthy growth and normal yield of crops depend upon certain optimum conditions of rainfall, temperature, humidity, wind, cloudiness, etc., in the air and soil layers with which the plant world is concerned. It is the function of the research workers in agricultural meteorology, to discover the exact way in which plant growth and yield are dependent upon the meteorological environments. Analysis of existing data has given ample evidence for concluding that of all the "controls", the climate factor is the one control which accounts for at least 50% of the variability of crop yields over a series of years. Manure, variety, cultural operations, etc. all combined account only for the remaining 50% of the variability.

It must be remembered that the march of climatic factors is by no means smooth and regular, as suggested by their normal values, during the growing season. In any single year these factors deviate at random and in varying degrees from the normal values. Often, the fluctuations of weather occur abruptly and with a violence which crops can hardly stand. Thus "weather" while it has a "benevolent" aspect upto a degree has also a "malevolent" aspect on crops, The major weather abnormalities and destructive meteorological phenomena which can affect crops adversely in India are :

(a) Excessive rains (floods), scanty rains (droughts) and untimely rains.
(b) Stroms, cyclones and depressions ;
(c) Thunderstorms, hailstorms and duststorms ;
(d) Cold waves accompanined by frost ;
(e) Heat waves, and excessive or defective insolation ;
(f) High winds.

When *heavy rainfall* occurs consecutively on a number of days and particularly over the catchment areas of rivers, the magnitude of the ensuing flood may well be imagined. For such large scale phenomena, the remedies depend on large scale planning and operative measures. The development of the catchment area of the Damodar on the plan of the Tennesse Valley in U.S.A., is an example.Many other similar major schemes are examples. A careful sifting of the facts of forestry in India has revealed that we are paying now for the errors of the past, for the indiscriminate and wholesale destruction of forests. A well-developed forest cover over a catchment area checks erosion and prevents too rapid a drainage of the flood waters into rivulets which discharge into major rivers and their tributaries For floods, the individual farmer can only keep drainage channels of his fields open. The development of "flood resistant" varieties of certain crops is also engaging the attention of agricultural workers.

The problems raised by *droughts,* or prolonged dry spells relate not only to the careful collection of rain water in a system of tanks, bunds, lakes, etc., and their distribution by a planned system of irrigation but also to the conservation and most economical use of the avaiable water in such reservoirs and in the soil as far as possible. Whereever feasible, resort should be had to sub-soil irrigation i. e. delivering the water at the root zone of the plants through suitable pipes. In arid parts like Rajasthan, such a system where practicable (e. g. in orchards) would prevent water loss by excessive evaporation which would occur in the case of surface irrigation and make the most effective use of the little moisture that may be available. In areas which are liable to frequent droughts, drought resistant varieties of crops may be introduced.

Then, there are the *Cyclonic storms* and *Depressions*. Besides the setting in of the monsoon early in June, its extension into India during June and July and finally its retreat southwards in September and October, weather in India is affected by other major phenomena like cyclonic storms and depressions. The fluctuations in the intensity of the southwest monsoon itself, are to a large extent, associated with a series of depressions which originate in or pass through the head of the Bay of Bengal and travel across the country in a westerly direction towards northwest India. Heavy rainfall occurs along the tracks of these depressions, The frequency of these depressions is 3 to 4 per month during the monsoon season, June to September.

During the period November to May, on the other hand, a series of western depressions enter India through Iran, Afghanistan, Baluchistan and the Northwest Frontier Province and move eastwards through north India towards Assam. These depressions cause cloudy weather and light rains accompanied by cold waves in winter. Their frequency is on an average two in November, four to five per month during December to April and about two in May.

The more severe cyclonic storms usually form in the Bay of Bengal and in the Arabian Sea in the transition months April to June and October to December, They enter inland and cause heavy rainfall and widespread destruction due to the high winds and occasional tidal waves. Their effects are most severe in the coastal tracts. We are all familiar with the very extensive damage to crops, live stock and human life and property caused by these storms. On an average, one or two severe cyclones may be expected in the pre-monsoon period and two or three in the post-monsoon periods.

One of the features of the colossal meteorological phenomena like cyclonic storms and depressions, is that their favourite directions of movement and speeds are generally understood so that the dates of their onset over a particular locality and the associated heavy rains and squally weather can usually be forecasted. Agriculturists can receive these warnings and take possible steps to save the growing crops, stored grain, live stock etc. Warnings of untimely rain and heavy rain, especially during sowing and harvesting periods will be most useful as the date of sowing may be postponed and the harvesting can be hastened, if the incidence of a storm or other large scale weather disturbance is expected,

Thunderstorms, Hailstorms and *Duststorms* are phenomena of short duration and their common feature is that they are accompanied by severe squalls in which the wind velocity reaches high values and cause destruction. In the absence of sufficient moisture, we can get only a dust storm. A hailstorm is a particularly violent thunderstorm. In many parts of India, e. g. in the Deccan, pre and post monsoon thunder. storm rains are sources of soil moisture for the growing crop. Hailstorms are, however, very destructive to standing crops and even to live stock and human beings The frequency of hailstorms is small early in winter but increases generally as the season advances into summer. Once the monsoon sets in, hailstorms are practically absent in the whole country. After the withdrawal of the monsoon, hailstorms begin to occur in the north and central parts of India. The frequency of days with hail is about 10 per year over the Himalayas. This decreases rapidly to once in two years over the plains of India.

Hilstorms can cause a lot of damage to crops. Protection against violent hailstorms is difficult, particularly under rural conditions. But the farmer who is warned before hand, can harvest his crops if they are already ripe.

During winter, the northern and central parts of India come under the influence of atmospheric disturbances called western depressions. These are associated with cloud and rain. These are soon followed by the cold waves when cold, dry winds from the northwest pour into the region. The *cold wave*, in its turn, extends or moves eastwards across the country weakening in the meantime. The minimum temperature attained by objects near the ground, like crops on a field fully exposed to the sky, is about 10° F lower than that attained by the air. In the north Punjab temperatures below the freezing point of water when the area is most liable to the incidence of frosts, occur on 10 to 20 days in each of the months of December, January and February. As one moves southwards or eastwards from this tract, the liability to frost decreases rapidly.

Prior warnings for the incidence of cold waves are issued by the Regional Forecasting Centres. On receipt of such warnings, the farmer or horticulturist can take the necessary precautions

Just as cold waves are injurious to crops in winter, heat waves in summer are prejudicial to their well being. The fundamental importance of clear sunshine to photosynthesis in plants is well known. During cloudy weather this activity is decreased, thus retarding growth. Also, conditions become favourable for the incidence of certain diseases and pests. Cloudiness is also injurious to crops during certain critical epochs like flowering.

The effects of *high winds* are many. The mechanical effect and possible damage to standing crops are obvious. If the air is hot, the rate of evaporation from water reservoirs and transpiration from plants and trees will increase enormously. On such occasions, plants are known to wilt and die owing to the rapid desiccation. The shrivelling effects of hot winds on grains at the milk stage is well known. Wind breaks are the only remedy. Wind breaks should consist of a line of trees planted at right angles to the prevailing wind direction.

WEATHER FORECASTING SERVICE FOR FARMERS

There can be no doubt that the farmer stands to benefit by warnings for adverse weather, when these are received by him expeditiously. For example, if he knows when the monsoon rains are likely to begin and later how the rainfall would vary during the season, and when breaks are expected, he will be able to time the various important cultural operations like preparation of seed bed, manuring. sowing, interculture, weedig, transplanting, harvesting, threshing, drying etc., with minimum risk to the crop and utilise his limited resources to maximum advantage. There are critical periods in the life history of a crop from the date of harvesting. Sowing time is one of no small anxiety to the farmer. He knows that a heavy shower just after sowing will wash away the seeds and seedlings and depress considerably the germination percentage. Again, if after sowing is completed, a prolonged drought followed, the tender seedlings would wither away and the entire crop may need resowing. If conditions are favourable in the first place, *viz.* the germination and early vegetative growth, the crop gets a good start in its career. Thereafter, intervals of clear weather are required for interculture and weeding. During the period of rapid growth or the "grand" period as it is called, the water requirement and need for sunshine for photosynthesis are maximum. There follows the period of flowering and reproduction, when vegetative growth has ceased. The period of flowering, fertilising and grain formation need clear weather and minimum cloudiness. Cloudy wet weather during this period can ruin a crop, very promising till then. When the earheads are forming and the grains are in the milk stage, one day's hot winds can shrivel up the grains. Even after the entire season has been passed safely, a heavy shower of rain or hail can do incalculable damage.

The weather has also another indirect control. Crops are liable to attacks of various diseases and insect pests during the season. The intensity of their incidence is dependent upon certain favourable weather conditions. One need be reminded only of the cereal rusts and the locust invasions to realise how many major enemies the cultivator has to contend with.

The India Meteorological Department has an organisation for issuing weather bulletins to the farmers through the All-India Radio. There are five Regional Forecasting Centres. *viz.* Calcutta, Delhi, Nagpur, Bombay and Madras. These centres issue the weather bulletins daily for farmers as part of the rural programmes. At present, they are issued in 16 languages from 23 broadcasting stations. For the reception of the weather reports, it will be essential that a sufficient number of radio receiving sets are available for the use of the farmers. This aspect of dissemination is extremely important and is under the serious consideration of the Goverment. There are some points to be borne in mind in judging these bulletins

There is considerable variation as regards the climate homogeneity of different parts of the country. For example, in districts of Rajasthan, the rainfall at neighbouring stations on a particular day may be more sporadic and variable than in an area like Malabar, Konkan or Bengal.

Weather phenomena in a tropical country like India have a tendency to occur distributed not always continuously but discontinuously like bubbles in a pan of boiling water. The present position of the Science of Weather prediction is such that forecasts and warnings can be issued ordinarily 36 to 48 hours ahead and in the case of major phenomena associated with storms and depressions, 48 to 72 hours ahead.

Phenomena like the thunderstorms and hailstorms are often very sporadic in their distribution and it may not always be possible to predict them accurately.

When the monsoon conditions have not been established, and the monsoon is late in arriving, or when there is a break in the monsoon, it may be possible to indicate in a general way that the cultivators will get little or no rain for a few days. But this forecasting for a few days under all conditions comes under the category of "Medium Range Forecastings" which yet requires much study. For agricultural purposes, the medium range forecaasting is of very great importance. This is one of the important subjects which is receiving the attention of the Meteorological Department.

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SIGNIFICANCE OF CROP COMPETITIONS IN THE GROW MORE FOOD CAMPAIGN

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and
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The enormity of the country's food problem is a challenge to every farmer and citizen of India. This problem is not merely one of dispensing with the food imports and attaining self-sufficiency; in the words of the Grow More Food Enquiry Committee, it is also one of bringing about "a large expansion of our agricultural production as well as ensuring the increasing population a rising standard of living"

Our agriculture, inspite of the war and post-war stresses has largely been of the subsistence type, The total and per unit production from our fields has largely remained low and inadequate to meet even the minimum nutritional needs of our people. Agricultural planning must therefore be directed towards organising this vital industry by introduction of scientific methods of agriculture and application of the valuable results of laboratories and farms. A sense of urgency must prevail in our efforts to bring the desired changes. The use of quality seeds of improved varieties, use of quality manures and fertilisers, the adoption of improved and modern methods of pest and disease control both in the field and storage should become normal agricultural practices within a short period of time.

The biggest single factor in increasing production is the farmer himself. The adoption of scientific techniques for agricultural improvement is as much dependent on economic considerations as on the enthusiasm and effort of the farmer. Accustomed to regard agriculture as a means of providing himself and his family with some food, he is scarcely aware of the larger problems of food production and his own part in solving them. It is, therefore, very necessary to arouse the enthusiasm of the farmer and enlist his efforts and willing co-operation in the campaign for growing more food.

Crop Competitions like others in various fields of activity aim at raising the enthusiasm of the farmer and canalising it towards greater effort in agricultural production. They provide the necessary incentive in producing higher acre yields by creating a healthy rivalry among the cultivators in the village and among the villages in the *hobli*. They induce the farmers to adopt new techniques and methods of production like increasing the available supply of manure by conservation, improving its quality, raising green manures, fertilising the land with nitrogenous and phosphatic fertilisers and paying undivided attention to soil and crop management througout the season, by emulating or excelling the efforts of his neighbours. The combined efforts and enthusiasm of the farmers in the competition area will raise the *tempo* of agriculture leading to increased production and adoption of better farming techniques.

Crop Competition is in a way a part of a larger programme of agricultural extension. It is one of the accepted and very fruitful methods of demonstraing the role of improved techniques in higher production of food and agricultural products and through higher production, of raising the standard of living of the farming community.

The crop competition fortnights organised during the growing season provide not merely an opportunity to set up a friendly rivalry between the farmers for greater effort and concentration on the job of production, but also for an appeal to their sense of patriotism and oneness with the country and her people. By doing their best they are not only enriching themselves by greater production but also get that exhilaating feeling of success and in doing so enrich the country too. They also get an intimate insight into the problems of agricultural planning and organised effort.

One of the characteristics of a progressive agricultural community is the desire to excel its own standards and crop competition is a potent means of developing such a desire.

These competitions give us an idea of the efficiency of our usual production methods and the potentialities inherent in adoption of improved techniques. This is very well illustrated in Table 2 relating to crop competitions held during the monsoon of 1953-54 in the paddy holdings of 200 farmers.

Column 7 shows the average yield per acre of paddy during 1949-50 the best of the three years during which crop surveys and crop cutting experiments were conducted by the Statistician of this Department. In coloumns 8,9 10 & 11 are shown the difference between the district average as obtained by competitors in the districts and taluks, the lowest yields and the average of the yields obtained by competitors (at the taluk level). In every case, they are very much higher than the average. Even the lowest yields obtained by prize winners is very much higher than the average for the area.

These figures show not only the present efficiency but also the potential yields that may be expected with some effort and planning. Such tables over a series of years give an indication of the progress or otherwise we are making in the Grow More Food Campaign.

Competitions in crops and livestock are essentially farmers' movements. The annual events are occasions to recognise and reward farming efficiency. The prize winners are, in a large sense, national heroes—the pioneers of to-day and the builders of tomorrow. Such occasions engender a new spirit of enthusiasm and unleash a desire for emulation instead of jealousy.

An assessment of the previous results of the Grow More Food Campaign indicated that the expected results were not achieved for lack of widespread enthusiasm among farmers. The crop competitions organised from last year are expected to bring into the Campaign a sense of voluntary participation in the important task of producing more food and thus contributing to the building of a healthier and wealthier India.

On account of dependence on rainfall and cultivation of inferior and marginal land by encroachment of grazing areas etc, intensive cultivation of such lands is generally not very fruitful. But where there are irrigation facilities the lands should be cultivated intensively both in the interests of the farmer and the nation. Hence crop competitions held on such lands yield very good results. The yields from those areas should be raised to the maximum potential by means of crop competitions. That it is possible to do so was shown last year.

In this crop competition for paddy organised in all the districts in the monsoon of 1953-54, 2000 competitors entered the competition for prizes at State, District, *Taluk* and *Hobli* levels The maximum number of entries were from Mysore District with 603 in the run. Sri Javare Gowda of Rudrapatna, Ramnathpur *Hobli*, Arakalgud *Taluk*, Hassan District produced the highest yield per acre—11,140 lbs. (55½ pallas) as against the average of 2,081 lb. obtained in the crop surveys, and he was awarded the first prize of Rs. 1,000. The yields of prize winners at district levels ranged between 6,840 lb in Chikamagalur and 10,000 lbs. in Hassan. A reference to the table shows that these yields are 2 to 5 times as high as the district averages. The district prize winners were awarded prizes of Rs. 200/-each.

At the *taluk* level, 51 prizes (of Rs.50 -) were given for yields ranging from 2,360 lb. to 9,564 lb. per acre. In Mandya and Shimoga competitions were held even at *Hobli* levels.

In Table 1 are shown the yields of prize winners in several yield ranges or slabs.

The prize winning yields were most frequent in the slab 5,000-8,000. Out of 61 prize winning yields nearly 66% fell into this group. This frequency shows that yields of 5 to 8,000 lbs are not very difficult to obtain. Tentatively we may fix the range 5,000-6,000 lb per acre as an easily attainable target for paddy production for the whole State with slight variations for districts.

After a few years of these competitions, the minimum may be fixed for each district and only those who exceed this minimum may be qualified for prizes.

It is reasuring to know from these competitions that higher production is not beyond either the organised efforts of our farmers or the capacity of our soils and agricultural techniques.

TABLE 1

Frequency Distribution of yields obtained by Competitors at State District and Taluk levels during crop Competitions (Paddy) held in Mysore State in 1953

Range of yields in lb per acre	No. of prize winners in the range	Range of yields in lbs per acre	No of prize winners in the range
1) 2,001– 3,000	2	6) 7,001— 8,030	12
2) 3,001– 4,000	1	7) 8,001— 9,000	7
3) 4,001—5,000	5	8) 9,001—10,000	3
4) 5,001—6,000	18	9) 10,000—11,000	1
5) 6,031—7,000	11	10) 11,001—12,000	1

TABLE 2.

Yields of Paddy in pounds per acre obtained by Competitors at District and Taluk Levels during the Crop Competition Held in 1953.

District	Highest yield obtained in the District	Higest yield obtained at *Taluk* level	Lowest yield at *taluk* level	Average yield among competitors in taluks	No of Taluks	Average yield according crop survey	Difference between Columns				Average yield estimated by Revenue authorities
							2 and 7	3 and 7	4 an 7	5 and 7	
1	2	3	4	5	6	7*	8	9	10	11	12†
Bangalore	9,175	8,270	2,560	5,558	8	1,704	7,471	6,566	856	3,854	822
Chikmagalur	6,840	6,400	3,600	5,621	3	1,652	5,188	4,748	1,948	3,969	1,113
Chitaldrug	6,908	6,058	4,919	5,488	2	1,507	5,401	4,551	3,412	3,981	1,014
Hassan	10,000	9,864	4,154	7,700	4	1,790	8,210	8,074	2,364	5,910	1,226
Kolar	7,952	7,735	4,340	5,636	5	1,629	6,323	6,106	2,711	4,007	816
Mandya	7,670	7,480	5,270	6,801	6	2,696	4,974	4,784	2,574	4,105	1,438
Mysore	8,400	8,360	5,040	6,490	10	2,568	5,832	5,792	2,472	3,922	1,892
Shimoga	8,850	8,440	2,600	5,812	8	2,061	6,789	6,379	539	3,751	909
Tumkur	7,502	6,877	5,200	6,228	5	1,793	5,709	5,084	3,507	4,435	1,010
Average	....	....	....	....		2,081		....	....	....	1,162

Highest yield obtained at State Level 11,140 lbs.

*This Column shows the average yield obtained by Crop cutting experiments during 1949–50, the best of the years during the period of crop surveys.

† This column shows the average yield as shown in the Season & Crop Report issued by the Revenue Department.

CROP SURVEYS IN MYSORE STATE.

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The Statistical section of the Department of Agriculture has been conducting crop cutting experiments on important crops. The main objects of the surveys are to

1. estimate the average yield per acre for the district and the State
2. study the variability in yields and efficiency of sampling technique for future surveys
3. collect information on the prevailing varietal, manurial and cultural practices
4. facilitate issue of accurate and timely forecasts on the basis of crop surveys
5. fix district normal yields

The survey started in Mysore State in 1949-50 with experiments on monsoon paddy, on State-wide scale. The survey was extended to ragi crop during 1950-51 monsoon season. During 1951-52 three more crops–*jowar bajra* and cotton were included, the surveys on *jowar* and *bajra* being on State-wide scale, that on cotton being on a pilot scale. In 1952-53 and 1953-54 monsoon seasons, pilot surveys on castor and groundnut were also taken up. Further, crop surveys are being conducted on summer paddy from 1950 and summer ragi from 1951.

These crop surveys are being planned and conducted under the technical guidance of the Statistician and Agriculutral Meteorologist. The field staff of the Department of Agriculture attend to the field work with the co-operation of the Revenue Department. The data collected from the sample are subjected to analysis of variance and errors of the estimates are determined. The efficiency of the sampling technique and plan for future surveys are also worked out. From the surveys, incidental information on prevailing varietal, manurial and cultural practices are also collected and analysed.

The following table gives the State average yields (in lb/acre) of paddy, ragi. *jowar* and *bajra* obtained from the surveys conducted so far

			Paddy	Ragi	*Jowar*	*Bajra*
1949—50	Monsoon	....	2,081.0	....	....	....
1950	Summer	....	2,322.2	....	....	....
1950—51	Monsoon	....	1,950·8	811.1	....	....
1951	Summer	....	2,318·8	1,422.3	....	....
1951—52	Monsoon	....	1,676.4	423.0	445.7	147.0
1952	Summer	....	2,024.0	1,115.1	....	....
1952—53	Monsoon	....	1,339.2	347.0	352·4	206.3
1953	Summer	....	2,178.8	1,339.3	....	....
1953—54	Monsoon	....	1,678.5	734.6	500.6	237.6

At present the estimates obtained from crop surveys are being utilised to form the revised estimates and to issue final forecasts in case of paddy, ragi, *jowar* and *bajra*. Sample surveys should replace the conventional method of crop estimation for all important crops in due course, and the estimates obtained from crop surveys should be utilised to issue crop forecasts.

FERTILIZERS IN CROP PRODUCTION.

By Dr. S.V. GOVINDARAJAN, B. Sc (Hons), Ph. D., A. R. I. C,.
Agricultural Chemist

The discovery of fertilizers is the most valuable boon that modern science has bestowed on Agriculture and this discovery came about not by a haphazard stroke of a genius, but by long years of silent and painstaking research both in the laboratory and in the field. This is a field in which both industry and the research laboratories have cooperated fully, to solve the problems facing a world with its ever increasing population.

The introduction of fertilizers as an aid to crop production was the outcome of the experiments of Sir John Lawes at Rothamsted, begun in 1843. Superphosphate was first prepared by him by treating phosphate bearing mineral materials with sulphuric acid and used on the Rothamsted farm in 1840; three years later the first factory was erected near London. The classical experiments then begun showed the value of sulphate of ammonia, a byeproduct from the new gas works, and of nitrate of soda which, although discovered some time previously had made little head-way as a fertilizer. The next important event was the opening of the Stassfurt salt deposits in 1860, which provided the key to the intensive cultivation of light (sandy) soils. Twenty years later came the introduction of basic slag, which did for grass land what superphosphate did for cultivated crops.

Early in the present century, the series of developments in applied chemistry began, and these put the nitrogen of the air at the disposal of farmers. Calcium cyanamide (1904) and calcium nitrate (1905) were the first comers followed in the years since the first World War by a large number of new synthetic nitrogenous fertilizers that have become popular over great parts of the world.

Artificial fertilizers differ from the older organic manures in that a certain amount of technical knowledge is necessary if the best results are to be secured from them. Their use has come to be established and the important role they play in incresed crop production makes it necessary that their nature and properties should be well understood by all.

SOIL FERTILITY AND THE IMPORTANCE OF MANURING.

A virgin soil is inherently fertile as it has, and supplies all the indispensable plant nutrients. But continuous cropping quickly exhausts this nutrient store and gradually the fertility of the soil diminishes. The soil becomes more and more infertile, and it is in this condition that a great majority of our farms are. Inadequate attention to the need for recuperating their fertility and lack of recognition of the need for replacement of what is taken out of them is the root cause of this.

The object of manuring is to secure that the crop shall find available in the soil an adequate supply of the elements necessary for its growth. Laboratory experiments and field trials have shown that a number of these elements are essential for plant growth, some being required in relatively large amount, and referred to as the major plant nutrient elements, and others in but minute amounts and consequently referred to as ' minor ' or " trace " elements. Under the first category come the following elements; nitrogen, phosphorus, potassium and lime which are required in quantity by plants and which because they may easily become limiting factors in crop yields are normally required to be supplied in the form of manures or fertilizers. The second group of elements under which come boron, copper, manganese, zinc and iron are usually present in sufficient quantity in soils, but may become inadequate to special crops or in abnormal conditions of soils.

The elements of the first group are by far the most imporatant and hence manures and fertilizers seek to supply these to meet the differing needs of crops and soils.

NITROGEN

This is supplied to the land in the form of the complex compounds, proteins and the like, occuring in organic manures or in relatively simple inorganic combinations such as ammonium sulphate or nitrate. It is taken up by the plant chiefly as nitrate, but some times as ammonia, the necessary transformation from the protein form being carried through by a chain of biological processes, the progress of which depends on the soil being in a good state for bacterial activity. Nitrates are quickly taken up by the plant, and the effect is observed in a few days. Deep green luxuriant growth is a sign of a good nitrogen supply. Excess of nitrogen leads to an accumulation of nitrogenous compounds in the plant, which may cause some loss of quality. Another common result is susceptibility to fungus disease.

The commonly used fertilizers supplying this nutrient together with the percentage content of nitrogen, are the following :

NAME OF FERTILIZERS.	PERCENTAGE NITROGEN.
Ammonium sulphate.	20.5
Ammonium nitrate.	32—34
Ammonium chloride.	24
Ammonium sulphate-nitrate.	26
Urea.	42
Chilean nitrate (sodium nitrate)	15.5
Nitrate of lime.	15.5
Calcium cyanamide.	21
Anhydrous ammonia (Liquid ammonia)	82

PHOSPHATE

Phosphorus is taken up by the crop as phosphates and the effect of this is to assist the early growth of seedlings, hasten maturity and improve root and seed development. The effect on vegetative growth is not marked unless the deficiency in the soil is very extreme, but the earlier start made by the seedlings of roots and cereal crops well provided with phosphate is usually very noticeable. The phosphoric acid in manures almost always occur combined with calcium. This is taken up along with the phosphate; plants manured with the ordinary phosphatic fertilizers, are therefore, enriched both with phosphate and in lime.

The commonly available phosphatic fertilizers are rock phosphate superphosphate and bonemeal. Their composition, as also of other concentrated fertilizers that are made avaılble to *ryots* are given below :

NAME OF FERTILIZER.		TOTAL PHOSPHORIC ACID PERCENTAGE.	AVAILABLE PHOSPHORIC ACID-PERCENTAGE.
Super phosphate.	....	18-20	14-18
Bonemeal.		23	9-10
Rock phosphate.		26	-
Triple super.	....	43	43
Nitro phosphate.	....	23	23
Ammonium phosphate.	....	49	49
Calcium metaphosphate.	....	64	53

POTASH

This is supplied in straw or plant residues or in the form of simple inorganic salts. Potash is associated with health and vigour of the plant and with the starch and sugar; it therefore finds its chief use for crops that store up large quantities of carbohydrate such as potatoes and other tubers. Cocoanuts, tobacco and sugarcane also require adequate quantities of easily available potash.

Potash is supplied commercially in the form of potassium sulphate (45-50 % water soluble potash) and muriate of potash (48-62 % soluble potash). The commercial grades contain lesser contents of potash than the pure salts and the percentages are usually described on the product. It is important in manuring to maintain a balance between potash and nitrogen. They exert opposite effects on the plant and when used in combination they are more successful than when used singly. This effect has been most closely observed in potatoes and other tuber crops.

The same principle is applied to the other nutrients. Thus, if heavy nitrogenous dressings are used, lack of phosphate may put a limit on production. In general, the heavier the manuring, the more important it is that it should be of a complete and balanced nature.

LIME

Calcium compounds must be regarded from two points of view. Lime is an essential plant nutrient, and the small amounts necessary for this purpose are supplied not only as calcium oxide or carbonate, but also in many of the common fertilizers, superposphate, nitrate of lime etc. Lime is also a soil amendment, for basic compounds of calcium such as quicklime or calcium carbonate, are the commonest agents used to correct acidity. Relatively large doses .will often be needed for this purpose. Under conditions obtaining in Mysore, sandy loam soils are found to require about half a ton of lime per acre to bring down the acidity by one unit. A further use is to improve the working qualities of clay soils, for which still heavier applications are usually needed. Addition of lime to soils usually enhance the availability of phosphates and hence improve upon the effects of added phosphatic fertilizer. In the case of soils which are acidic in nature, under which category come the soils of *Malnad*, lime application should, be an essential operation, if the full advantages of phosphate application are to be derived.

SOIL STRUCTURE: ITS IMPORTANCE IN SOIL FERTILITY

By B. V. VENKATA RAO, B.Sc.,

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The importance of soil structue as a major factor in soil fertility is being increasingly realised. It is a common experience in intensive cultivation of crops like sugarcane that the productivity of land steadily decreases inspite of adequate irrigation, manuring and cultural attention· In such cases the loss of soil structure is one of the main causes responsible for decline in productivity of land.

A casual examination of soil reveals that it is composed of particles of varying sizes. For purposes of study the soil particles are divided into 4 size groups namely coarse sand (dia. 2 to 0.2 mm) fine sand (dia. 0.2 to 0 02 mm.) Silt (0.02 to 0.002 mm.) and clay(dia less than 0.002 mm). These size groups are quite arbitrary except that particles less than 0.002 mm. are known to exhibit colloidal properties and the properties of soil such as moisture, rententive capacity, stickiness, and the ease with which the soil could be worked depends upon the content of clay in the soil. Though no such division of the soil particles into these size groups exists in reality, it is very useful in the textural classification of soils. A soil is described as clayey or sandy or loamy on the basis of its mechanical composition and we are in a position to give a quantitative basis to the layman's description of soil as regards its texture.

The arrangements of the various sized particles of the soil in the field to a depth of 3 to 5 feet is called structure. The two possibilities in which soil particles can exist are (i) each particle of the soil functioning as individual by itself, and (ii) several particles adhering together to form bigger particles or granules or crumbs and then functioning as individuals. The single grained structure is unusual in soils. It is possible in a very sandy soil. The puddled paddy field is another example of the existence of soil particles as separate individuals where the soil aggregates have been destroyed by trampling and the soil particles brought into their primary state to prepare a soft bed for planting paddy seedlings, This is only a very temporary phase in the paddy cultivation and the soil develops a compound structure quite soon after planting. The single grained structure results in compaction and is most unsuitable from the point of view of movement of air or water or spreading of plant roots and root hairs. A soil is said to be in good tilth when optimum conditions of moisture, air supply and facility for penetration and spreading of plant roots are present. These conditions obtain when the primary particles will have adhered together to form bigger individuals or granules or crumbs, resulting in greater pore space of not only of capillary size within the granules capable of retaining moisture in thin films, but also of bigger pores between the granules which facilitates proper aeration and drainage of excess of water. The soil tilth or in other words the presence of an arrangement of soil particles which ensures optimum supply of air, moisture, room for root penetration and spreading and activity of micro-organisms is a pre-requisite for successful crop growth.

When the soil is under forest or grass it possesses this favourable soil structure, but when brought under plough there is depletion of organic matter due to excessive oxidation, disturbance of the root system of natural vegetation holding the soil particles together ultimately resulting in the loss of structure.

The dangers of soil erosion is a much publicised fact. The primary cause for erosion or removal of surface soil material from cultivated fields is the loss of structure. The soil whose natural structure has been destroyed is incapable of absorbing and allowing the water received through rain to reach underground sources. When the rain water does not reach its normal and natural destination, it overflows the surface along the slope with considerable velocity removing with it the valuable top soil causing gullies and ravines, making good land unfit for cultivation. This in turn results in silting of tanks and resorvoirs, reducing their capacity and crops in the *achkat* areas are rendered a precarious proposition.

The uncontrolled floods in rivers and rivulets in rainy seasons is also a result of loss of soil structure. The sponge like soil under natural vegetation facilitates the absorption and gradual release of rain water into the water courses, thus avoiding the sudden rush of all rain water into the rivers and rivulets.

The factors that influence the cementing of primary soil particles into secondary particles are colloidal clay, colloidal oxides of iron and aluminium, colloidal organic matter and nature of the exchange complex. Colloidal nuclei and water molecules attached to them carry elecrical charges and constitute the force which brings together primary particles and produce granulation of soils. Many soluble salts also exert a strong flocculating effect on soils and may induce granulation of soils. This aggregation of soil particles is also facilitated by lines of weakness in soil mass such as roots of plants which help drawing together of soil particles around a new nucleus and formation of a structural unit.

Under forests and grasses there is a fair balance between the different forces at work and the soil maintains a desirable structure. This is disturbed when land is brought under plough. Methods approximating with nature's way of balancing the opposing forces have got to be employed to prevent destruction of structure of soil in arable agriclture. Rotation of suitable crops is an age old practice. Introduction of leguminous and other crops possessing deep and extensive root system in rotation in between shallow rooted crops like paddy, ragi and *jola* and cash crops like sugarcane or cotton or tobacco is very desirable from the point of view of maintenance of soil structure. If crop rotation is not possible, growing a green manure crop such as sannhemp, horsegram and cowpea and ploughing in the same at proper time will go a long way in this direction, since both tops and under ground portion of the crop forming considerable quantity of organic matter gets incorporated into the soil. Green manuring or rotation of crops is not a practicable proposition in dry land cultivation where year after year ragi or *jola* is grown, Under those conditions mixed cropping of ragi with crops, like groundnut, *avare*[1] and cowpea on a much appreciable scale than at present is a convenient substitution to achieve the benefits of either crop rotation or green manuring adopted in irrigated cultivation. Over and above all these, good soil management practices like ploughing with suitable implements under optimum moisture conditions, intercultivation, keeping surface mulch, application of bulky organic manures such as compost and farmyard manure are all aids to maintain proper soil structure.

SOIL FERTILITY; WHAT IT IS AND HOW TO MAINTAIN IT

By. B. BHEEMASENA RAO, B. Sc.,

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What is Soil

Before trying to know what soil fertility is, it is necessary to understand the meaning of the term soil. The term ‘Soil’ can be conceived as a porous mass made up of a hard frame work plastered over with a jelly-like substance consisting of several chemically active substances, (such as clay, a small amount of fine silt containing silica and oxides of iron, aluminium and other metals) plant foods and unstable organic substances rich in available energy, while the pores contain air and water. In a compact arable soil 60 to 70 per cent of the volume is soil, the rest being empty space filled with air and water. This water exists in the form of a solution having carbon di oxide, nitrates, carbonates and other salts dissolved in it and this is held in soil partly by surface attractions and partly by the existing colloids. Further, the pores of the soil are inhabited by millions and millions of organisms of varied nature some of them being visible such as earth worms etc. and others called soil bacteria invisible even under a powerful microscope. These depend upon the organic matter of soil converting it into useful plant food.

Soil Fertility :

A fertile soil may be described as one in which the conditions are favourable for the growth of plants useful to man. The main fertility factors for plant growth are (a) soil water, (b) air, (c) temperature, (d) plant foods, (e) root room and (f) absence of harmful factors. It is thus necessary to have a knowledge of the part played by each of these factors to ensure fertility.

(a) *Soil Water* :—Generally the soil receives water from rain and the subsoil but it loses the same by evaporation and drainage. Factors such as rain fall, temperature, nature of the soil etc. determine the actual amount of water present in the soil and this water-holding capacity of the soil is

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(1) *Dolichos lablab*

one of the factors to determine fertility. Too much of clay in the soil renders it impervious to rain water and thus causes it to lie waterlogged, while too much of coarse sand in the soil makes the water drain away quick and thus increases the loss by rapid evaporation. But the bad effects of too much clay may be modified by liming or laying deep drains while excessive sand may be counteracted by the addition of clay or tank silt or by ploughing in organic manures and green leaves. In all these cases water supply may be improved by extending the range over which the roots may grow. Stagnant water must be prevented from raising too high either by tapping the springs or by laying deep drains. Loss of water by evaporation may be checked by skilful cultivation or by spreading a fine layer of fresh soil which effectively shields the rest of soil from sun's heat and keeps the moisture safe from loss.

(b) *Air supply* :— The harmful effects of the waterlogged area are not so much due to the excess of water as they are to the exclusion of air within the soil. As the plant roots and the food making bacteria alike need air, all parts of the soil should have free access to it. Once the excess of wather is drained off the air rushes in to take its place. Such devices as liming of clayey soil, laying deep drains, breaking up a pan, rock etc, help to regulate the supply of water and air.

(c) *Temperature* —Maintenance of optimum temperature necessary for the plant growth can be effected both by draining away the excess of water and also by checking losses of heat through evaporation and this can be done by sheltering from the wind by hedges and by maintaining fine tilth of the soil. Further, the heat received may be concentrated on certain parts of the soil by laying ridges running east and west.

(d) *Food supply* :—This depends upon the mineral constituents of the soil and accumulation of plant residues which are converted into plant food through the agency of soil bacteria. Increase of plant food in the soil can be achieved by adding fertilizers such as sulphate of ammonia, nitrate of soda etc. and organic substances such as farm yard manure or cakes, guanos etc. or by growing leguminous crops. Phosphates are supplied in the form of bones, supers, guanos, rock phosphate etc. Except in certain cases potassium compounds generally existing in the soil are sufficient for ordinary purposes. The foregoing can be summed up by saying that the nature of plant residues and the ease with which they are decomposed by soil bacteria depend upon the climatic factors such as temperature, water supply etc. and also on the amount of carbonates present in the soil. On the whole we may safely conclude that a soil suited to the growth of plants is also suited to the activity of bacteria and therefore to the production of plant food. Fertility is thus determined not merely by the amount of plant food that exists per unit volume of the soil but it is dependent upon the extent of root ranges as in the case of water.

(e) *Root Ranges* :—Besides sufficient supply of plant food and water for a plant to thrive it is necessary that a soil should afford ample space for full development of its root system.

(f) *Absence of injurious factors* :—It is known that, in wet soils poor in carbonates, harmful substances do exist and this is ascribed to the so called 'sourness' of the soil which can be removed by good drainage, addition of line and proper cultivation. 'SICKESS' of the soil, biological in nature, can be remedied by partial sterilization.

Out of the six foregoing fertility factors the first three e.g. water supply, air supply and temperature being interdependent, the three leading factors that determine soil fertility are the water supply, food supply and the lime status of the soil, for when these are satisfactory the other three will also be favourable for plant growth.

SOIL TYPES :

In dealing with soil fertility it is necessary to know the composition (both physical and chemical) of different types of soils. The main types of soil are three : (1) Sandy (2) Loamy and (3) Clayey.

1. *Sandy Soils* consist chiefly of inert silica and about 6 per cent of clay, poor in mineral constituents supplying plant food. Sandy soils induce good root development, early maturity of high quality. (2) *Loamy Soils* contain more of clay material and less of sand. (6 to 15% of clay + 40 to 60% of silt, + 20 to 50% coarse and fine sand.) These contain more plant food and better water supply than sandy soils and ensures heavy yield though not early. (3) *Clay Soils* contain more clay. ie. about 25% and above. Their stickiness do not allow free root development. Clays are less fertile than sand or loam though they contain more plant food and water than the other types. To sum up, loams give good and heavy crops, sands are easily workable and afford possibilities in the way of cropping, whereas clays are well suited to grass, wheat and beans, the three crops of great importance to the *ryot*.

SOIL FERTILITY AND THE SYSTEM OF HUSBANDARY :

A close kinship exists between the composition of the soil and the crops grown on it and a closer kinship between the soil fertility and the system of husbandry. Composition of the soil, its situation and climate are the factors that determine the equilibrium level of fertility and it undergoes a change by altering any of these factors. Thus each soil may very in composition and therefore in its fertility between two limits, the upper limit under permanent vegetation, and the lower limit under plough. These limits are set by the nature of the soil and the climate but the cultivator can keep at any level by changing his mode of husbandry. This difference between these two limits of fertility is not entirely a problem of percentages of nitrogen or carbon existing in the soil. At the upper limit of fertility the soil possesses a physical structure owing to the flocclation of clay and the arrangement of the particles and it can be easily brought into fine tilth which is needed for the seed bed.

HOW TO MAINTAIN SOIL FFRTILITY ?

Though it is difficult to reduce the modern agricultural systems into any simple rigid order yet their general bearing on the fertility of the soil may briefly be summarised as below :—

(a) The supply of plant food is regulated by the addition of appropriate fertilizers in adequate quantities. This problem cannot be solved merely by way of finding out of the analysis as to what mixture manures would be most appropriate but direct trials would suffice.- Such trials have often shown the needs of the commercial crops on important types of soil, being the application of chalk or lime as and when required.

(b) It is necessary to keep up the supply of nitrogenous matter in the form of compost or farmayard manure to the soil. Greater eoonomy is effected by feeding the animals on the arable land, thus overcoming the necessity for making the f.y.m. in which there would be heavy losses of plant nutrients and organic matter. Crops are therefore grown suitable for the animals to eat in the field itself.

(c) Judicious management of grazing combined with dressings of super, basic slag, lime and potash salts, if need be, lead to the formation of dense turf. By this way the land gains good supply of nitrogenous organic matter and thus its fertility tends to reach the upper limit.

SUMMARY :

The foregoing may be briefly summarised as follows:—The problem of making a soil fertile consists in first finding out the conditions which the plant requires for its proper development and then altering the soil to make it meet these requirments. Selecting the crops naturally adapted to the climate and the soil, would be most economical. To alter the soil to our requirements, the actual conditions of the soil must first be ascertained and then ways and means found to change the same. These soil conditions fall mainly into four groups ;–

(1) *Physical Strucrure* of the soil which determines the movement of water, (and thereby of salt), air, and of plant roots within the soil.

(2) *The Chemical Composition* which reveals the amount of plant nutrients present in the soil together with those adverse to the plant growth.

(3) *The nature and the amount of soil bacteria* that are present in the soil both helpful and detrimental to the plant growth.

(4) Factors such as *climate, situation of the soil, nature of the sub-soil* etc., may play an important part in determing the fertility of the soil.

All the above are under control to some extent. The first is altered to help the plant growth by adequate cultivation, addition of organic manures (f.y.m. or compost) and if necessary lime, chalk, clay etc. The second may be entirely altered by the supply of appropriate fertilisers in adequate quantities. The third *i.e.* the control of soil bacteria is also being tried and varied to suit our purpose. The fourth, though less easy to change can be modified by way of altering the subsoil *i.e.* by breaking the pan or rock layer and improving the drainage.

Though the above are the general principles, yet in applying them care should be exercised to balance the probabilities in each case. For, means taken to alter the physical condition of the soil may react on the soil bacteria,the chemical composition and *vice versa*. As the soil is always cultivated for benefit, economic considerations do come in at every turn. Thus fertility problems which are more complex than they appear at first sight, demand a close study in the laboratory, the pot culture house and the field before they can be conceived as solved.

SALINE AND ALKALINE SOILS

Prevention and Reclamation

By H. G. GOPALA RAO, M. Sc.,
Assistant Chemist, Division of Agricultural Chemistry.

It is a frequent and somewhat bitter experience for many an agriculturist to find that his land has become 'Saline' or Alkaline'. Crops fail to grow and mature properly. Application of the usual fertilisers do not improve the condition. The soil structure deteriorates. Sometimes earnest attempts are made to improve this condition by empirical methods but more often than not the land is ultimately abandoned in despair. The insidious spread of this dreaded 'Alkali' disease over wide areas of what was once fertile and productive land year after year makes this problem one of paramount importance to be effectively solved in a balanced agricultural economy.

SALINE AND ALKALINE SOILS: ORIGIN

How do these soils originate ? As their names indicate they are the products of heavy accumulation of salts is the soil. These salts may be of several kinds but the chief are Sodium corbonate (black alkali) ಚೌಳು in Kannada, Sodium sulphate (white alkali) and sometimes Sodium chloride (common salt). The distinction between 'Saline' and 'Alkaline' soils is not clear cut and is purely academic, as in nature one changes to the other gradually and vice versa. By popular usage however. it is taken that the 'Alkaline' soils contain high content of sodium salts whereas the former type contain in addition calcium and magnesium salts. These salts do not originate locally from parental rocks but are transported from higher elevations by the movement of the groundwater carrying them in solution. They accumulate at lower levels where they rise to the surface and prove harmful under the conditions. (1) When the rate of surface evaporation is greater than atmospheric precipitation like rain or dew. This type of salt concentration on the surface has occurred extensively in the nearly arid irrigated lands in Molakalmuru Taluk in Mysore. Rainfall in this region is less than 10 inches per year. Salt brought up to the surface of the soil by the evaporating soil moisture has accumulated extensively on paddy lands many of which have become unproductive and are being slowly abandoned for cultivation. (2) When the ground water table is so near the surface that capillary contact is established between the water table and the surface moisture. This type of formation occurs in the low lying areas in the highly irrigated tracts in Mandya and Maddur taluks.

In either of the above types the upper zones of soil become so charged with salts that root growth is inhibited and ultimately stopped. The soil assumes a sticky claylike structure owing to the presence of sodium salts (sodium clay), which impedes drainage. The grain structure of the soil is lost.

In view of the permanent damage that the formation of 'Alkaline' soils causes to agricultural lands it is wise to adopt some simple precautions, briefly indicated below, to avoid salt accumulation on the land.

1 By restricting surface evaporation by using a good soil mulch like organic manure, compost manure etc., or preferably by growing protective green manure crops like horsegram during the dry months of the year.

2. By providing good drainage to the land. Irrigation water should drain off freely all the harmful soluble salts. Stagnation and local evaporation result in the concentration of salts.

3. By providing good irrigation water which is reasonably free from dissolved sodium salts. It is always important to note that when the drainage is defective irrigation with water containing a high concentration of salts result in the accumulation of the latter in the soil, Where there is good drainage however, water with a limited salt content may be used without any injury.

As pressure on existing cultivated lands increased due to conditions ot food scarcity in recent years, unproductive areas like 'Alkaline' and 'Saline' lands were brought under the plough in many regions of the world. Various methods have now been adopted successfully to reclaim extensive 'Alkali' lands. It is not the intention here to deal exhaustively with the costly and long term measures that were successfully adopted in countries like Palestine and America. A few of them however, are capable of being adopted on a small scale in our country and they are briefly described here.

Heavy application of organic manures:—Experience in several parts of the State has shown that high applications of green manures, farmyard manure at 10 to 15 cartloads per acre or molasses (2-4 tons per acre) over successive years has improved the fertility of the lands and given very good crops. Almost any organic manure may be used and in this connection mention may be made of the application of filter press mud by the Mandya Sugar Company for the purpose. The effect of this method of treatment seems to be somewhat temporary and will last for two or three seasons only. Moreover large quantities of of manures are required for this purpose and this is beyond the means of the average cultivator.

Flooding—When there is abundance of irrigation water the land may be liberally flooded occasionally. This will dissolve the harmful salts and leach them out in the drainage. This method can be used only when the soil is well drained or otherwise, when adequate open or tile drains are provided. This method is used extensively in America but in this country water is generally too precious to be used very liberally.

Application oj Chemicals—The two chief chemicals usually used for this purpose are gypstum and sulphur. Gypsum (composition $CaOSO_4\ 2H_20$) contains calcium and this calcium will replace the harmful sodium salts in the soil. The quantities to be applied is to be fixed according to the degree of alkali development on the land but generally is in the region of 2 to 4 tons per acre. The cost of gypsum at the current market rates is Rs. 45/- per ton.

Sulphur is also used extensively in foreign countries for land reclamation as it is converted into sulphuric acid by soil bacteria, thus neutralising soil alkalinity. This however. is effective only on soils containing adequate calcium. Moreover, as India is dependant on foreign supplies of sulphur, it is usually not available for soil reclamation purposes.

It is obvious from the above that the reclamation of alkaline soils is a laborious, expensive and long term process and the short time measures are not nearly effective. Emphasis is thus to be laid on the prevention of alkalinity in the soil by judicious land husbandry and irrigation which is cheaper and more prodnctive of results in the long run.

MANURING OF PADDY -A SHORT NOTE

BY H. G. GOPALA RAO, M. Sc.,
Assistant Chemist, Division of Agricultural Chemistry

The urgency of stepping up the food production in the country has brought to the forefront the importance of manuring the paddy crop. Till very recently, the paddy crop in India was grown with practically no artificial fertilisers, the only manure used being bulk organic manures like green leaves, farmyard manure and compost. No phosphatic or potassic fertilisers were applied. These treatments resulted in a general low level of production in the country. The yield of paddy in India per acre is among the lowest in the world as is shown in the following table.

TABLE

Showing Comparitive Yield of Paddy per acre in Different Countries of the World.

COUNTRY		Average yield of paddy in lb. per acre
Italy	....	4,189
Turkey	....	3,133
Burma	....	1,197
China	....	2,235
Japan	....	3,529
Spain	....	3,643
U. S. A.	....	2,358
Argentine	....	2,939
India	....	898

It is, however, well established now, through experiments conducted by the several agricultural departments in the country that paddy responds to applications of artificial fertilisers particularly to nitrogenous fertilisers like ammonium sulphate. The response, however, is varied and limited. In the various trials conducted in Mysore State over more than a score of years, significant response has been found only upto 30 pounds of Nitrogen per acre (150 pounds of ammonium sulphate) exclusive of bulk organic manures, like green manures, farmyard manure or compost. Higher doses of nitrogen are uneconomical and generally result in poor grain formation and large vegetative growth resulting in lodging of the crop.

Paddy yields do not usually show any increases with either phosphatic fertilisers alone or with potash, though phosphates is combination with Nitrogen do show a positive response. Also, when the phosphatic fertilisers are applied to a green manure crop which is grown and ploughed in before paddy, the yield of the succeeding paddy crop is increased. An attempt is made below to indicate the latest trends in the successful manuring of the paddy crop as found in Mysore by experimentation and experience.

The manuring of a paddy crop falls into several stages each of which is directly related to a stage of growth of the crop. In a normal transplanted crop they may be said to occur as follows.

1. Nursery
2. Puddling
3. Transplanting
4. First weeding

MANURING OF NURSERY

In India, the nursery is rarely intensively manured, the popular impression being that a manured nursery produces seedlings with weak stems which cannot give a good stand. Usually the nursery bed is only manured with limited quantities of farmyard manure or compost. In the southern coastal districts of Bombay State a method known as '*Rab*' is followed. Combustible organic matter like cowdung, leaves, dried sticks straw etc. are piled on the nursery beds to form a layer upto half a foot in thickness & the whole is covered with a thin covering of soft earth. This is set alight just before rains and after ashing, the plots are cultivated and sown. This practice, for various reasons, has proved advantageous to the locality and appears to be widely adopted.

The intensive manuring of the nursery bed, however, is common in foreign countries paritcularly China and Japan. In these countries the nursery is prepared with the utmost care. In the Japanese method, the nursery is prepared on narrow dry raised beds in strips with adequate provision for free root development. The beds are usually well drained. Manures at the rate of 20-30 lb. of farmyard manure and ½ lb of a manure mixture of ammonium sulphate and superphosphate are applied for every 32 sq. feet of seed bed which represents a fairly high dose of fertilisers for the nursery as our traditional ideas go. Recent experience in this State has shown that the same dose appears to be suitable under our conditions also.

MANURING AT PUDDLING

At this stage the bulk organic manures are usually applied. Farmyard manure or compost to the extent of 6-8 cartloads per acre are applied now. When a green manure crop is grown on the field it is cut and ploughed in at this stage. The commonly raised green manure crops are sannhemp alone or mixed with horsegram, greengram, cowpea and sesamum. The yield of these crops varies from 3,000 lb of green matter per acre in poor soils to 15,000 lb. and over in fertile soils. Fertilising this green manure crop with superphosphate applied at the rate of half to one hundredweight per acre is known not only to increase the yield of these crops, but also to enhance the yield of the succeeding paddy crop.

If no superphosphate had been previously applied to the green manure crop, it is preferable to apply it at the time of puddling. This enables the phosphate being worked well into the soil zones where it is easily available to the paddy plant roots. Under our conditions it is observed that applications of superphosphate at half a hundredweight per acre is usually adequate for paddy.

Whe then green manure crop is not grown in the field, green leaf manuring is adopted, a quantity of 3,000-5,000 lb. (6-10 cartloads) per acre being applied. The most popular green leaf for this purpose is of the '*Hongey*' plant (*Pongamia glabra*) which is plentiful and grows almost everywhere. If it is not available, green leaves of any leguminous plant or of any green plant may be applied. Among the recent green manure plants successfuly introduced are *Glyricidia maculata* and *Sesbania aculeata* (Dhaincha) both of which are prolific yielders, yielding on an average from 5,000 to 10,000 lb. of green matter per acre.

The green manure not only adds nutrients to the soil but will also improve soil tilth and structure. It is essential that the green leaf manure should be worked deep into the soil either by some implement or by trampling and allowed to rot for at least 8 to 10 days before transplanting. Undecomposed or partially decomposed organic matter in puddled condition is apt to prove harmful to the freshly planted seedlings.

MANURING AT TRANSPLANTING STAGE

This is the stage at which the crop is top dressed with nitrogenous fertilisers. The usual nitrogenous fertilisers used are ammonium sulphate and oil cakes. They are given in a single dose at the time of transplanting or split into two equal doses, one-half of nitrogen given at the time of transplanting and the other half at the time of first weeding. usually one month later. When the doses are divided, the oilcakes are usually included in the first dose and only ammonium sulphate is applied in the second dose. As indicated earlier, application of 30 lb of nitrogen per acre in the form of groundnut oilcake and ammonium sulphate (112 lbs and 115 lb respectively per acre) is observed to be the most useful in Mysore. When this quantity is split up into two doses, the first one will consist of 112 lb of groundnut oilcake and 40 lb of ammonium sulphate which is applied at transplanting and the second dose will consist of 75 lb of ammonium sulphate applied at first weeding or one month after transplanting.

MANURING AT FIRST WEEDING

Recent research on the nutrition of the paddy plant has shown that paddy needs high supplies nitrogen at two stages in its growth. Once, when the young seedling is first transplanted in the puddled field and the other 10 to 15 days prior to flowering. This latter period generally coincides with the first weeding and occurs at about 4 to 6 weeks after transplanting. Field experiments conducted in departmental farms in Mysore State have indicated that application of the second dose of nitrogenous fertilisers at about a month after transplantation is the most advantageous from the point of view of high grain formation and yield. Since this also coincides with first weeding when the roots are normally stimulated, absorption of nutrients it fairly rapid.

In the above only a brief outline of the manuring practice that is popular in the progressive agricultural areas in the State with assured suppplies of water is given. Paddy is a crop grown under a variety of soil, climatic and cultural conditions and no uniform procedure of manuring can be formulated. Naturally, where intensive cropping and double cropping is practised manurial doses will be high; where the crop is grown under rainfed conditions as in the *malnad* region the doses are kept down in keeping with soil moisture and atmospheric precipitation. The correct dose is to be fixed taking into account all these factors and the results of local field experiments.

MANURING OF POTATOES: ITS INFLUENCE ON THE YIELD AND CONTENT OF PROTEIN AND PHOSPHORUS OF TUBERS.

BY B. V. VENKATA RAO, *Assistant Chemist*

AND

Dr. S. V. GOVINDARAJAN, *Agricultural Chemist.*

Potato is an important commercial crop in Mysore and is intensively cultivated in many taluks of Bangalore, Kolar and Hassan districts. Over 6,000 acres are brought under this crop which is normally grown during two important seasons, namely from May to September and from December to March. The out put of this crop in the State is estimated at over 20,000 tons valued at over 70 lakhs of rupees.

Like other money crops potatoes are intensively manured with a view to obtaining increased output and with it larger returns. The usual practice adopted in manuring this crop is to apply 8–10 tons of farm manure per acre, and though the use of chemical fertilizers is not a widespread practice, many cultivators realise that the crop responds readily to nitrogenous fertilizers and so apply ammonium sulphate at the rate of 2-3 cwts. per acre. In view of the economic importance of this crop, experiments on manuring have been carried out in the Chemical Section for a number of years. This work carried out on plot scale in the potculture house attached to the laboratories of this Department on the response to nitrogen, phosphoric acid and potash, singly and in combination has indicated that the optimum dosage for the red loamy soils typical of the northern taluks of Bangalore, is 50 lb. N, 25 lbs. of P_2O_5 and 25 lbs. of K_2O over a basal dressing of farm manure. Manuring in addition to increasing the yield of the crop is also known to influence the composition of the crop. Potatoes being an important item of diet of our people, the effect of manuring on its important constituents of nutritional value, particularly protein and phosphorus, was considered to be an important aspect deserving study and the samples from the differently manured crops were analysed.

Various workers in different parts of the world working on the problem of potato manuring have reported steady responses to applications of nitrogenous fertilizers and generally stress the importance of applying a mixture consisting of all the three major constituents namely N, P, and K. A few workers have also reported the advantage of including magnesium salts in the fertilizer mixture. Though information on the influence of manuring, on the composition of tubers is not extensive, some workers from the continent and the U. S. A. have reported the beneficial influence of nitrogenous manures on the protein content and of the phosphatic and potassic fertilisers on the mineral content of tubers. The results obtained from the experiments conducted during the past 6 years are summarised below and indicate the influence of the different fertilizer mixtures on the yield and composition of the tubers.

Treatments.	Yield of potatoes in maunds[1] per acre,	%of Protein	% Phosphorus.
1. Control – No fertilizers	336.6	1.99	0.066
2. N. only.	538.6	2.22	0.065
3. N + P	582.5	2.63	0.075
4. N P + K	588.3	2.92	0.080
5. N + P applied at 3 inches depth	590.1	2.63	0.083
6. N + P + K + Mg.	659.3	2.76	0.076

N = 50 lb. of N as a mixture of Am_2SO_4 and groundnut cake in the proportion of 1 : 1.

P = 25 lb. of P_2O_5 as superphosphate;

K = 25 lb. of K_2O as sulphate of potash.

Mg = 25 lb. of Mg as magnesium sulphate

A mixture made by mixing 3½ cwt. of groundnut cake, 125 lb. of ammonium sulphate 1½ cwt. of superphosphate and 50 lb. of sulphate of potash would supply the manurial ingredients per acre in the NPK mixture mentioned above. This mixture may conventiently be applied at a depth of 3 inches in the furrows through seed drill before planting potatoes. The cost of these manures would work out to Rs. 50-60 per acre and as indicated by these results may be expected to increase the yield by 50 percent and more, over the no fertiliser treatment. Further, it can be expected that the tubers will be richer than the unfertilized crop in both protein and phosphorus both of which are very essential constituents of human diet.

MANURING OF ARECANUT PLANTATIONS

By K. K. NAMBIAR, B.Sc., (Ag.)

Secretary, Indian Central Arecanut Committee, Calicut.

In order to get adequate returns from a crop, it is essential the crop should be judiciously and systematically manured. This is more so in the case of a perennial crop like arecanut. Mixed cropping of arecanut with coconut, pepper, betelvine, plantains, cardamoms, vegetables, and root crops is a common feature in some of the arecanut growing areas. So it results in greater depletion of the soil. It is therefore necessary to have a well laid out manurial programme for arecanut gardens to increase the production.

The practice of manuring the palms exists only in certain regions such as Mysore, South Kanara, North Kanara and South Malabar. The manures usually applied are green leaves or cattle manure, every year or once in two or three years according to the economic condition of the cultivator.

Though no regular experiments have been conducted to find out the optimum requirements of manures for arecanuts, the trials at Marthur (Mysore State) have shown that in a garden of about 400 trees per acre a combination of 10, cart loads of cattle manure, 5 cart loads of leaf manure followed by an application of a mixture of 200 lb. of groundnut cake, 80 lb. of ammonium Sulphate, 400 lb. of super or bone meal and 300 lb. of sulphate potash (if available) once in three years, gives satisfactory returns.

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[1] 1 Manud = 28 lbs.

Empirical data available with certain *ryots* reveal that applications of groundnut cake and farm yard manure to arecanuts give good results.

Application of green leaf manure, besides improving the soil texture also adds humus to the soil and prevents losses by leaching. Green manure crops can be grown with success in arecanut garden itself. *Crotalaria striata*, wild indigo, *Sesbania speciosa* etc., can be grown and either seedlings or seeds of *Glyricidia maculata* can be planted all round the garden.

Transporting good soil from outside and putting it in arecanut gardens is a good practice which enriches the land. Trenches in arecanut gardens when they get silted up partially, can be utilised for applying the manures and then covered up with the soil transported from outside and fresh drains dug in between other rows of arecanuts. This practice may be repeated periodically. The husks of arecanuts that are being wasted at present may also be used for manuring, by uniformly spreading them in the trenches along with other manures and covering them up with soil.

Thus judicious and systematic manuring of arecanut gardens augments the production and helps in diminishing our deficit.

THE DEVELOPMENT OF FLUE CURED VIRGINIA TOBACCO IN MYSORE STATE.

By M. L. SUBBANNA, B. Sc., (HONS)

General Manager, Mysore Tobacco Company, Bangalare.

The Mysore Tobacco Company was floated in 1937 as an agricultural cottage industry with about 300 barns scattered in groups of 10-20 in 31 centres, all over the State, for the development of virginia tobacco. We engage during the season, 1,500 labourers a day both at the centres and at the Grading Station, thus providing a livelihood to the farmers during their off time. We spend on labour alone Rs. 6 to 8 lakhs every year. The farmers who grow tobacco are kept busy throughout the year with a second crop in rotation with paddy. The tobacco is confined mainly to areas of Mandya and Kolar Districts.

From 1949 onwards, the Company has been making steady progress. Ten per cent dividend has been declared consecutively for four years and the Company has built up some reserves for further development.

The Company's activities come under three categories ; viz., cultivation in *ryots*' filed, curing at the Company's barns and grading, redrying and selling at the Whitefield Grading Station.

The F.C.V. Tobacco is grown in Mysore in a season different entirely from Guntur. It is grown under irrigated conditions in rotation with paddy. Our farmers say that paddy coming after tobacco comes up very well. The nursery is started in February and March, and planting in May and June and the curing is done in the months between July to October ; whereas, in Guntur, tobacco is grown under rainfed conditions and the tobacco operations are started at the close of the season in Mysore.

The farmers grow F.C.V. tobacco under an agreement to sell their green leaf to the Company at prices fixed at the beginning of the year. The Company raises nurseries in all the curing centres and supplies seedlings to all the growers.

NURSERY

The seeds from reputed sources are obtained and tested before sowing in the nursery. The nursery lands are usually sandy loams. They are ploughed thoroughly in January and allowed to dry completely for a month, then ploughed again and beds are formed. The beds are, as a matter of rule, burnt thoroughly. Compost manure is applied to the nursery lands. Then a thick layer of sand is spread over every bed. According to a formula, the fertilizer mixture is applied. We have a seed sowing apparatus for sowing seeds on the beds evenly. The seed rate is 2 to 2½ lb to an acre of nursery. An acre of nursery will produce seedlings enough to plant 100 acres. A layer of paddy straw is spread over the beds to give protection to the germinating seeds from severe sun.

The seeds germinate in about a week's time. As the seedlings begin to grow, the thick layer of paddy straw is thinned gradually and finally removed. Spraying with Bordeaux is done very frequently. 40 days old seedlings are usually given for transplanting. Before issue, the seedlings are hardened by abstaining watering. This is a very important work which gives .added strengh to the seedlings to stand against drought in the fields. If the seedlings are properly hardened, they will have a hard stout stem and stubby growth and bushy root system. This profuse root system and short growth enables the seedlings to thrive better under even adverse conditions in the field. Luxuriously grown seedlings are thin and lanky which do not stand the strain of transplanting under adverse climatic conditions. Seedlings before issue to farmers are sprayed with Bordeaux.

Borer attack is common. Badly affected seedlings are discarded. Slightly affected ones can be squeezed at the swollen portion were the borer is in hiding.

CULTIVATION IN THE FIELDS :

The lands are selected before the issue of seedlings. Swampy alkaline soils are not selected. The farmers are advised to and insisted upon to cultivate their lands properly by our field staff.

A fieldman is appointed to look after 30 to 40 acres of lands in a compact area. Fertiliser mixture is issued to the farmers for application to the lands in the presence of the field staff.

Not more than 5,000 seedlings are allowed to be transplanted. Both ways intercultivation is rendered feasible by 3 feet spacing either way along the row and between the rows. Manuring experiments are conducted in the farmers' fields, the results of which are passed on to all the farmers. Topping is usually done for crops on light soils ; on heavy soils it is not practised.

Weeding is done to keep the fields clean and frequent intercultivation helps in this. Sandy leaves are removed to prevent diseases appearing and spreading. The only disease which affects the crop in Mysore is the 'Ash' disease. This occurs in moist dull cloudy weather. The 'Ash' disease does great damage to crops and spreads like wild fire from field to field. When the sun shines, the disease disappears. Orabanche rarely occurs.

Two months after transplanting, the leaves are ready for picking. The field staff issue a permit to such of the *ryots* whose fields are ready for picking. It is only just ripe leaves that are picked early in the mornings in the presence of our field staff and carted to the curing centres. The leaves are weighed and weights are entered in a pass book issued to each grower. The pass book contains all the entries relating to issue of seedlings, manure from the company and his supplies of green leaves to the company. Payments are made as soon as the dues assume a respectable sum. As the *ryots* do not like to be paid piecemeal, they are paid in two intalments in lumpsum—one at the middle and the other at the close of the season.

Thereafter, the work is entirely of the Company's. The first battle in the field is won with all the goodwill of the farmers.

In the last two years, an incentive scheme had been instituted to encourage farmers to apply themselves intensively to the cultivation of tobacco andproduce better type of leaf and earn more money, 80 prizes were awarded to the best cultivators on the basis of money realised. This has enabled the Company to increase its prosperity on the basis of the co-operation and the goodwill of the farmers, A good crop in the field is of mutual benefit both to the farmers and to the Company. Last year, the prizes were distributed by the Hon'ble the Chief Minister, Sri K. Hanumanthiah, to the farmers.

CURING

It is an art which only a trained hand could handle with advantage. The green leaf is all handled in open green leaf sheds under supervision. They are graded on the degree of ripeness and the dark green leaves, the overripe leaves, bruised leaves and immature leaves, are discarded in the shed alone. The grading of green leaves is a very important one. By doing this, we can discard all the leaves which will not cure well. The graded leaves are strung on horses by daily paid labourers. They are loaded in the order of ripeness. There should be no mixture of leaves in any tier. Our barns are usually double furnace barns measuring 20' x 20' x 20'. 8,000 lb are loaded to the maximum. In the curing, the new schedule set by the Research Institute of Rajahmundry[1] has been adopted with advantage. Our curings are over in about 100 to 110 hours. Shifts are arranged for looking after the curings both day and night, Curing costs are kept as low as possible.

Our own supervisors handle the curings. We also conduct experiments on curing by varying the methods. We have three aluminium barns and a Buck Eye Oil Furnance. We have made some improvements in the furnace with the help of M/s. V. R. Brothers (Extension), Bangalore, and the results are very encouraging.

The cured leaf produced at all the centres in handled at the Grading Station at Whitefield. The cured leaf of each centre is graded separately. The grading results are reported back to the individual supervisors then. and there cautioning them to obviate the defects in their previous curings

Final figures of cured leaf grading of all the centres are compiled and a comprehensive statement of facts and figures are sent to every supervisor. This gives them an assessment of their work. Incentives are given to the best curers by way of special increements and bonus. M/s. Indian Leaf Tobacco Development Co., Ltd., have promised to award two shields to

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1. The new schedule is described in a later page of the calendar—*Ed.*

each one of the areas viz., Mandya and Goribidanur to the best supervisor who produces the largest quantity of cured leaf comprising higher percentage of top grades. Our thanks are due to them for this gesture.

The cured leaf is graded in up to date grading hall constructed last year with north light arrangements. The hall has been equipped recently with the latest humidifying appliances. Bangalore weather during November to January is chill and dry and the cured leaf goes into scrap while grading. The scrap percentage would sometimes go up considerably putting the Company to huge losses. The scrap percentage is reduced under humid and cool atmospheric conditions provided by the humidifiers.

After the grading is over, stripping of top grades of tobacco is done under the humidifiers. This enables us to handle leaf with ease and minimum percentage of scrap. In F.C.V. meant for cigarettes, it is the tobacco in leaf form that has a value and the scrap has no market even at 3 pies to a pound[1]; hence the value of humidifiers could be better appreciated. We have an up-to.date Redrying Machine which can handle about 1,200 lb an hour. The tobacco strips, leaves and stems are redried and sold to our buyers who are chiefly the Imperial Tobacco Company, Limited, Bangalore. We have a Moisture Testing Oven to determine the moisture content of redried tobacco.

There is another aspect of our activity. There are private curers in our State. The Company generally issues barn materials, seedlings, and manure on credit or the farmers who own barns and cure their leaves. The method of sale is that cured leaf is taken in our lorries to the Grading Station where it is graded in their presence. The prices are fixed on each grade and the claims are settled then and there on the basis of the grading results. Thus a fair deal is assured to every private curer. The encouragement of F.C.V. tobacco in the private sector provides a very useful occupation to the farmers at their very doors.

In addition, we have employed a special staff to supervise their work and guide the farmers in their curing operations. We make sure that the farmers handle the curings properly and produce high percentage of top grades. The farmers send out their representatives to undergo training in curing to any one of our 18 centres. Sometimes, we take a batch of the private curers round our centres to show them handling of greenleaf and curing it in the barns. To stimulate and enthuse the farmers in their work, special valuable prizes are awarded to them along with the green-leaf growers.

Lastly, the grading results and realizations of all the private curers are compiled together and sent to each one of the private curers. This gives them an idea as to how to improve their quality and make more money. Every year, we have arranged to increase the tobacco activity in the private sector. Barn materials are given to farmers on very easy terms. When they start work, our supervisors frequently visit them and advise them as to how to grow the crop well in the field, and how to cure the leaves properly to obtain more of the top grades which brings in good money.

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[1] The uses to which these scraps can be put is referred to in the next article-*Ed*

In the Mysore State, there is a Tobacco Safeguarding Act which enables us to control the development of F.C.V. tobacco. No farmer is allowed to build a barn without the permission of the Company.[1] The farmars are further prohibited from using any cheap seed of unknown quality. We supply them either seeds or sell seedlings at Rs. 2-8-0 per thousand.

EXPORT TRADE.

Some of the low grades are usually left behind for which there is no market in India even at very low prices. But it is our good fortune that we have been able to find a sale for all our low grades B and DB on the continent at very competitive prices. All our low grades of 1952 have been sold out. Our buyers seem to be satisfied with our standards and have been pleased to place a firm order with us for the present year's entire low grades B and DB stocks. The Mysore Virginia Tobacco is valued most on the continent

This is a very encouraging feature and we shall try our utmost to develop our trade on the continent, There are many friends from different parts of the continent, making kindly enquiries about our tobacco

The Mysore Tobacco Company covers all aspects of tobacco activity from the nursery to the curing and selling of tobacco. This is a unique institution in the whole of India which stands for the development of flue cured virginia tobacco in the State. The tobacco is a short term cash crop which is in great demand both locally and on the continent and therefore, there is a great future for this Industry. But there should be proper Government control over the production of quality tobacco, and on the marketing of tobacco at favourable prices.

The growers and the employees of the Company, are deeply grateful to the Board of Management for their solicitude and for giving all the encouragement and affording facilities in their activities.

WEALTH FROM TOBACCO WASTES

BY

DR. M. S. PATEL, M. Sc., Ph. D. (N. Carolina)

AND

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Indian Central Tobacco Committee.

The role of tobacco in the country's economy is of multifold importance. Agriculturally, it brings to the Indian grower an annual return of about Rs. 45 crores, although its total acreage is only 34 percent of the total crop area in India. Commercially, it fetehes for the country foreign money to the tune os Rs. 15 to 18 crores. By way of excise duty it enriches the nation annually by about Rs. 34 crores. Besides, it provides means of livelihood to a very large number of persons in the various branches of the industry.

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[1] According to rule 9 under the Mysore Cigarette Tobacco Safe guarding Act 1939, the Director of Agriculture is the licensing authority—*Ed.*

TOBACCO SEED

The economic potentialities of its by-products have however not yet been fully appreciated. The first by-product which is met with in the industry of tobacco production is the seed. In our country it is only the cigarette tobacco which is allowed to seed besides ratoon crop of *bidi* tobacco. The inflorescence of all other types of tobacco are topped to give high yield and heavy bodied leaf. It is estimated that about 4,000 tons of seed are annnally produced in India. Till 1951, this was more or less allowed to go as waste. Experiments have shown that cattle,. if fed with tobacco seed by grinding it into a paste, thrive equally well as when fed with similar costlier feed. It does not contain nicotine or any harmful substance.

TOBACCO SEED OIL.

Like seed, oil is also free from nicotine and other harmful substances and has been proved to be quite suitable for culinary purposes. During War, when supplies of groundnut oil went short, tobacco seed oil was being consumed in European countries like Bulgaria and Germany.

Experiments have further shown that it can be used as a semi-drying oil in the manufacture of enamels, paints and varnishes. The tobacco seed oil has a signifiant advantage over linseed oil in as much as it does not turn yellowish on keeping. It has been further reported that tobacco seed oil, when properly treated, yielded better results than linseed oil in the preparation of varnishes and ready mixed paints. Its film had good gloss, adhesion, flexibility, water and electric resisting properties.

The oil burns quite steadily giving a mild and smokeless light. The consumption of oil is also lower as compared with other oils. The following is the analysis of combustion tests on different types of oil :-

Kind of oil.		Duration of light for 3 oz. oil
Tobacco Seed oil	....	21 hours.
Groundnut oil	....	21 ,,
Pungam (Pongamia glabra) oil	....	20 ,,
Ippah (Bassia latifolia) oil	....	20 ,,
Margosa oil	....	20 ,,
Mustard oil mixed with 25% groundnut oil.		25 ,,

The oil has also been tried with success against small insects and white ants. Casuarina posts when treated with this oil were not attacked by white ants. It is estimated that the present extraction of oil from available seeds is about 150 tons anually.

OIL CAKE

Tobacco oil-cake which is cheaper in price than other oil cakes has been successfully applied as manure in areas of production to crops like sugarcane and paddy. Feeding trials with this cake conducted at the Agricultural Research Station, Guntur, has, proved that it had no adverse effect on the animals. The cake is also fed to horses in other parts of the world.

TOBACCO DUST

The next by-products of the tobacco industry are dust and waste. Experiments undertaken by the Indian Central Tobacco Committee have indicated that dust, when applied to tobacco crop over a basal dose of groundnut cake, increases the yield and, in a way, matures the crop earlier than when treated with groundnut cake alone. Application of stem-dust has an additional advantage of incorporating into the soil large amounts of organic matter which improves the texture and water holding capacity of the soil—a very important factor in our farming.

TOBACCO WASTE

By far the most important by-product is the tobacco waste. It contains about 0.6 to 4% of nicotine sulphate according to the types of tobacco. This is a powerful insecticide and is at present entirely imported at a cost ranging from Rs. 50/-to Rs. 95/-per lb. A cheap plant to extract nicotine on commercial lines from tobacco waste has been recently designed by the National Chemical Laboratory at Poona.

About 38 million lb. of tobacco waste are almost annually destroyed in India. Besides, about 25 million lb. of stem which, perhaps for its limited use in blending with *hookah* tobacco or in adulterating *bidi* tobacco, are of little use. The cost of these together is roughly estimated at Rs. 2 crores which has so far been more or less a national loss. With the manufacture of nicotine sulphate from the waste not only this loss of Rs. 2 crores will be saved but India will also be able to conserve foreign exchange expended on imports of nicotine sulphate.

The possibility of extracting potassium sulphate, a very valuable manure, from the stalks of virginia tobacco is already under consideration. This fertiliser is also at present imported into India from Europe at about Rs. 500/-a ton. Annually about 60,000 to 80,000 tons of this manure is imported from abroad for manurial and other chemical purposes If the extraction of potassium sulphate proves successful and economical on a large scale, it will be a step forward in our home industry.

From the foregoing it will be obvious that the economic utilisation of these bye products which are at present of little market value, even on modest cottage industry scale, can yield premia and will employ manual power relieving to a certain extent the problem of growing unemployment in the country. It will also provide employment to tobacco growers and other agriculturists in their off season when the agricultural operations are slack or at a stand still.

CURING OF VIRGINIA TOBACCO[1]

Farmers are very well aware that curing of Virginia tobacco require expert knowledge and careful handling of the leaf. A good or bad curer will make all the difference between success and failure of a normal tobacco crop. Since curing is a very important process, studies in better methods of curing were taken up by the Institute with a view to improve the quality of leaf, as well as to save fuel if possible. The Institute had opportunities to let some farmers cure their leaf by their own curers at the farm and at the same time similar leaf from the same fields was also cured by a modified method of curing by the Institute's curer.

It was found that by the Institute method there was an average saving of 966 lbs. of coal, worth Rs. 19 - per charge. The better quality produced by the Institute method was reflected in better prices and on an average the leaf received Rs. 20-13-0 *more* per candy than the leaf by the farmers' method. The farmers' method on an average required 5 days and 17 hours as against 4 days 14 hours by the Institute method—thus saving more than a day in curing,

In order that the recommended schedule can be followed easily, the corresponding stages in the usual procedure followed by the farmers is also indicated below. It is absolutely necessary to furnish the barn with a dry and wet bulb mercury thermometer, which is obtainable at a cost of about Rs. 25/-*, so that the necessary operations can be done more correctly. The ordinary "curo-meters" are not sensitive enough for this purpose.

It is desirable that properly ripe leaves and of as uniform a maturity as possible should be harvested for curing. Due to the unfortunate practice of getting fields harvested by contract too much of improper leaf is included in harvesting. It is also a good practice to grade the leaves into green and light green before stringing. The darkest leaves should be loaded in the upper half of the barn and lighter ones in the lower half. Farmers tend to overload the barn. A single barn should not be loaded with more than 600-650 sticks.

FARMERS' METHOD.	INSTITUTE METHOD.
1. *Yellowing:*—Temperature 85°F to 105°F.	1. *Yellowing:*—Temperature-Dry bulb 85°F to 105°F. Wet bulb 28°F to 94°F.
Time 30 to 40 hours.	Time 30 to 40 hours.
(*a*) During the first few hours after loading, barn is closed tightly by sealing with mud all doors and ventilators, furnace not charged.	(*a*) Furnace charged after loading and temperature raised by 5°F to 6°F above outside temperature. Top ventilator left very slightly open, especially during the cooler hours of the night; bottom ventilators left open with slight gaps so that upward movement of air continues in the barn.

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1. Leaflet No.5 issued by the Indian Cental Tobacco Committee.
2. Central Tobacco Research Institute at Rajamandry.

* Obtainable from; (1) Messrs The Andhra Scientific Co., Masulipatam; (2) M/s Scientific Instrument Co., Mount Road, Madras-2; (3) Central Scientific Works, Thambaram, Madras. They may also be available from any of the leading shops in large towns.

(*b*) Furance charged after 8–12 hours and temperature gradually raised to 105°F by 2°F or 3°F an hour and allowed to stay until leaf is ready for fixing. Ventilators continue to remain closed.	(*b*) Temperature rised by not more than 1°F to 2°F an hour reaching 105°F by the time leaf becomes yellow and ready for fixing. It is important to raise temperature in such a way that yellowing is nearly completed by the time it reaches 105°F. Top and bottom ventilators gradually opened to 3 inches or so.
2. *Fixing colour :*—Temperature 105°F to 125°F. Time. : 3 to 9 hours. Progressive total time: 37–47 hours. Temperature rapidly increased to about 125°F by 4°F to 5°F per hour. Bottom ventilators now opened wide. Top ventilator also completely raised.	2. *Fixing colour* :—Temperature–Dry bulb 105°F to 120°F. Wet bulb 93°F to 98°F. Time : 5 to 10 hours. Progressive total time: 39-47 hours. *Great care is required at this stage in raising temperature.* It is raised by not more than 1°F to 2°F every hour. Bottom ventilators opened to 5 to 6 inches at the base. Top ventilator raised to a height of 6 to 8 inches from the roof. *It is not necessary to raise the top ventilator completely.*
3. *Leaf drying* Temperature : 125°F to 145°F. Time: 47–79 hours. Progressive total time: 84–120 hours. Temperature raised very rapidly (4 to 5°F an hour) and maintained at 145°F or so until the lamina is completly dry. Ventilators are left fully open throughout. It is at this stage that coal consumption is greatest in this method.	3. *Leaf drying* Temperature. Dry bulb 120°F to 145°F.—Wet bulb 90°F to 108°F. Time: 40–51 hours. Progressive total time: 80–100 hours. Temperature raised less rapidly by not more than 2° to 3°F an hour. When temperature reaches about 125°F to 130°F *first the top ventilators and then the bottom ventilators are begun to be lowered.* Careful watch is kept on the wet and dry

	bulb thermometer reading throughout this stage. The difference between the dry bulb and the wet bulb thermometers is allowed to go on progressively increasing. *In no case should the difference be allowed to fall to less than 15° to 20°F.* If the difference tends to narrow down it can be widened by opening the bottom ventilators temporarily. By the end of about 19 hours it should be possible to close the ventilators completely. The bottom ventilators are also progressively closed in keeping with the top ventilators.
4. *Stem drying* :—Temperature 145 °to 165°F.	4. *Stem drying* :—Temperature Dry bulb 145° to 160°F. Wet bulb 110° to 104°F.
Time: 26–43 hours.	Time: 16 to 27 hours.
Progressive total time: 127 to 146 hours.	Progressive total time: 100 to 124 hours.
Temperature is raised very rapidly and all the ventilators are closed and sealed.	Temperature raised and maintained at a maximum of 160°F until the stem is dry;—the ventilators having been already tightly closed during the later part of the leaf drying stage.

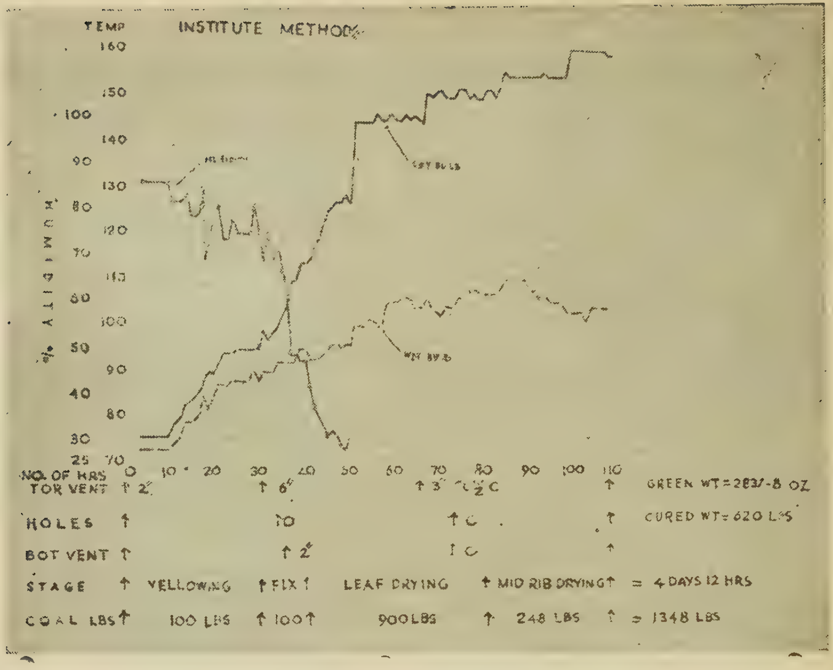

Fig. 2. A graph showing an actual run of the barn by the Institute method. Note the uniform rise in temperature and corresponding reduction in humidity. Compare coal consumption in each phase of curing with the farmers' method. There was a saving of a day by this method.

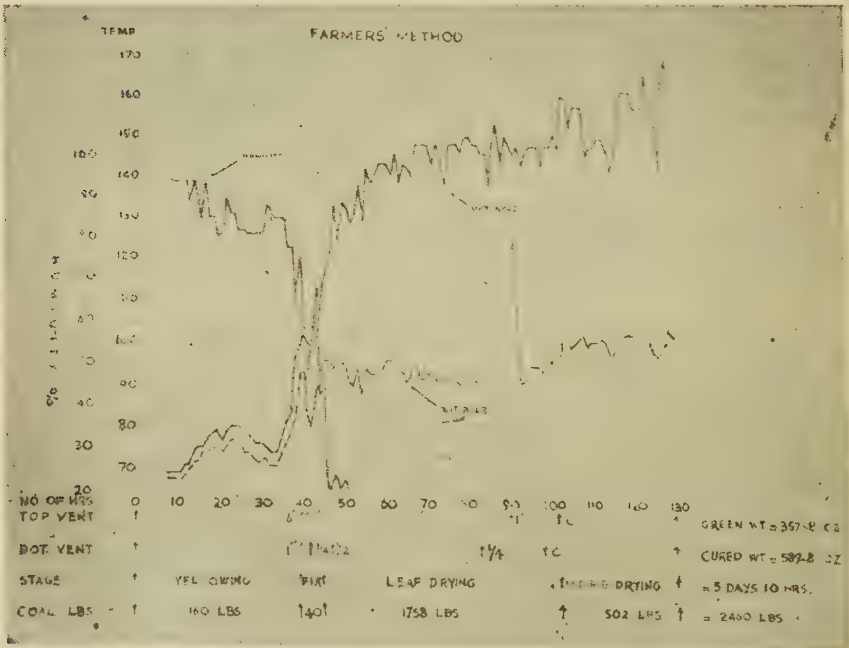

Fig. 3. A graph showing an actual run of barn by the farmer himself. Note the constant variation in temperature throughout the whole period. Note excessive consumption of coal during the leaf and the midrib drying periods.

SWEET POTATO VARIETIES AND CULTIVATION

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Sweet potato is a well known food rich in starch. It is an exotic crop like potato introduced from tropical America. Unlike potato, the cultivation of sweet potato is less costly and the crop itself is more hardy, easy to handle and suitable to be grown over a wider range of soils. It is now established as a vegetable and poor man's food.

ACREAGE

In Mysore State the acreage is highly variable and ranges from 2000–6000 acres. The extent of cultivation depends on the success or failure of the millet crops. Considerable acreage under this crop is found in Hassan, Kolar, Bangalore and Tumkur Districts. In Hassan, it is cultivated under rainfed conditions, while in other districts, it is mostly a garden crop raised under irrigation. Individual plots under this crop never exceed half to one acre under irrigated conditions but in Hassan district large acreages come under this, as a dry crop.

SOILS AND PRELIMINARY CULTIVATION

A light well drained sandy loam with a clay sub soil is the ideal condition for a successful cultivation of sweet potato, although it can be grown under a wide range of soil conditions. A good drainage is a very essential feature. Sweet potatoes are particularly well adopted to lands newly brought under cultivation. A very fertile soil often tends to produce vines at the expense of roots, and also the roots produced will be rough and irregular in shape.

The field is ploughed twice and thrown into ridges of flat beds depending upon the local practice prior to planting. As depth of ploughing has an influence on the shape of tuber neither deep nor shallow ploughing is advocated. In monsoon planting ridges are preferred while in summer flat beds.

PLANTING MATERIAL AND SEASON

Sweet potato is generally propagated by cuttings of vines—although in some foreign places roots are used as planting material. In the former practice about 12,000 to 15,000 cuttings with 5–6 nodes are necessary for planting an acre, with a spacing of $1\frac{1}{2}'$–$2'$ between rows. In the latter case usually $\frac{1}{8}$ of the area required to be planted is first planted with roots and the sprouts from these are planted subsequently in the rest of the field. The latter practice incidentally helps in, giving scope for selection of roots with desirable characters.

There are two main planting seasons in practice—May and November under irrigated conditions, while under rainfed conditions, the planting is done during June-July.

AFTER CULTIVATION AND MANURING

The vines take nearly three weeks to root. The best time for planting is immediately after rains or otherwise frequent light irrigations would be necessary in the first fortnight after planting. Shallow intercultivation is necessary to keep down the weeds, until the vines run out and completely cover the surface. The vines produce adventitious roots, at the nodes, and this should be checked as these roots develop into fingers (immature tubers) at the expense of the main roots. To avoid this the vines are lifted once in a fortnight, popularly called as " Rolling vines". Nipping of the growing tips, also serve the purpose but it results in low yields.

Sweet potato crop is usually not manured in Mysore. But, application of artificial fertilizers definitely results in increased production of roots. Experiments are under way to fix up the manurial schedule for sweet potato, and also the economics of manuring and the type of manure to be used. Preliminary indications show that application of nitrogen increases the yield up to a certain limit.

Spacing between rows and between plants and systems of planting varies—the local practice, however, under garden conditions, being flat beds with 1½′–2′ spacing between rows. Experiments to determine the optimum spacing and the best method of planting are also undertaken.

MATURITY AND YIELD

It is not easy to judge the maturity of the crop by any external indications, as sweet potato continues to grow and produce fresh vines and leaves as long as favourable conditions for growth exist. The only sure method of judging maturity is trial digging and examination of roots. When cut, the latex of mature roots hardens quickly while that of immature ones continues to be watering, even after exposure of an hour or more. The crop usually comes to harvest between 4–4½ months. The average yield under local conditions is 4 to 5 tons but under favourable conditions the yield can easily be doubled.

VARIETIES

A commercial crop is a bad mixture of types and it is not uncommon to find roots of more then one variety in the same field. This is a bad practice and should be avoided, since it results in low yields as there are types which are poor yielders and should be removed. Another feature is that the nature of starch and sugar content varies and a mitxure of these is rather unfavo urable when sweet potato is used either for edible purposes or for commercial purposes. Growers should select only such varieties as are in demand in the market. A white variety is in greater demand in areas round about Hassan while the red varieties are preferred on the Bangalore market.

The Department of Agriculture has been trying to up—grade the yield and quality of roots by introduction of high yielding varieties and by local selections and improvement. Under a Scheme sanctioned by the Indian Council of Agricultural Research, this work has been intensified.

A collection of types from various parts of the State was made and from these, on the basis of root colour, shape, size, and yield, ten types were isolated. These were under trial for three years and three high yielding types have been established for distribution. They are Hosur green, Hosur red and Raja. In several field trials conducted, these three on an average, have given 30% more yield than control. The variety Raja has red tubers with an irregular shape and a wrinkled surface. Hosur Green and Hosur Red have a straw yellow colour with light red splashes. They are uniformly spindle shaped with a smooth surface. In all the three varieties the flesh is white.

Reputed varieties from other parts of the world were introduced to acclimatize them to local conditions and to judge their performance. 14 American, 10 Ceylonese, 4 Chinese, 1 Philippines and varieties from different parts of the Indian Union, have been obtained. Out of these the American varieties are promising. They have attractive pink coloured roots, a few white and saffron, with uniform spindle shapes, or conical or napiform. The flesh is coloured orange, showing richness of carotene. As per preliminary data collected a few varieties have give higher yields than local. These are still under critical test. Varieties like B. 4004, Unit No. 1, Pellican processor, are in yield trials. But one disadavantage of these varieties, are in the greater susceptibility to attack by weevils.

A Chinese variety F. A. 17 White has also given high yield in the observation plots and this is also under yield trials.

Besides these, a large number of seedlings are also under different stages of test. Sweet potato flowers and sets seeds freely under conditions existing at Hebbal, Bangalore[1]. Advantage was taken of this and a large number of seedlings were raised. As many as 3,000 seedlings were studied and 21 selected and finally retained for trial. A wide range of variation was observed in the leaf shape and size, colour, shape and size of the roots. Selections were made mainly on the basis of root characters like shape, size, number of roots per hill, etc. Roughly amongst the seedlings studied two factors were noticed as being correlated. The cordate entire leaf was in most cases associated with good root formation and the completely green leaf usually was correlated with straw yellow roots.

Of the 21 seedlings mentioned, the following are in yield trials *viz.*, Seedling 64, 85, 106, 135, 600 and 1162.

It has been the experience of many workers, that seeds of sweet potato germinate with great difficulty and the germination is usually uneven. Several methods of seed treatment like scarifying, abrasion treatment with acids have been employed to obtain even and a high percentage of germination. At Hebbal, excellent germination has been obtained by placing the seeds in shallow trays, pouring boiling water over them and allowing them to cool and soak for an hour

SOME ASPECTS OF SWEET POTATO EXTENSION

Sweet Potato is the most important of the several subsidiary food crops to redress the cereal shortage. It has the added advantage of being a garden crop and not having to compete with cereals. Any improvement in production will be worthwhile because our people are used to this as a subsidiary food and have a liking for its taste and flavour. Its possibilities as part of our daily food intake are immense since it contains 9% more carbohydrates and 9% less water than potato.

For successful extension of sweet potato area in the State, problems like storage, availability of planting material of high yielding varieties and marketing facilities of the crops have to be solved.

In the absence of proper storage facilities, sweet potato deteriorates rapidly and the producers will be compelled to sell their produce at low prices to prevent loss due to spoilage. Availability of planting material at the proper time is also a problem particularly in dry cultivation. Special nurseries in the season in areas where this crop is contemplated to be raised on a large scale are necessary to provide planting matarial of improved varieties, Grading to conformed standards is also a worth while practice and deserves to be introduced.

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[1] Not all varieties set seed; out of the 11 varieties selected by this Editior when he was working on the crop at Hebbal between 1944-46, only 3 flowered-Ed.

The Department has planting material of the improved varieties and interested cultivators can obtain, limited quantities of these. Already the varieties Hosur green, Hosur red, Raja and Deenabandhu have been released to cultivators. Results obtained so far indicate the superiority of these over local. Hosur green and Hosur red have usually given heavier yields than Raja and Deenabandhu. (vide photo).

The Food Value of Sweet Potatoes·

Sweet potatoes are mainly energy yielding food with a fuel value of about 570 calories per pound. In addition to 18% starch they contain 4 to 5% sugar but this varieties from variety to variety. They are naturally rich in the enzyme diastase which converts starch into sugar. Though at ordinary temperatures the diastase shows little activity, at 55 to 65°C the conversion of starch in the sweet potato to sugar is very rapid. When cooked, nearly all the starch is changed into malt sugar. Hence sweet potatoes are really a saccharin food rather than a starchy food. The protein content of sweet potato when compared with many vegetables is high—2 to 3·5%. These proteins are a good source of the amino acids which are essential for growth and nutrition of animals and which are deficient in some seeds and food grains. So the sweet potatoes should be regarded as valuable supplement to correct the deficiency of proteins of wheat, maize etc and of seeds like cowpeas, lentil etc. In any case, they are richer in *true* proteins by more than half of potatoes; for the nitrogen in the Irish potato is in the form of amides which do not have the food value of proteins. No amides are found in sweet potatoes. The human requirement of Vitamin A is roughly 4,000 International units per day. A person eating 150 grams of sweet potato (about 12·85 *tolas*) two or three times a week will have all the vitamin needed.—(*Editor*)

DUTCH SEED POTATOES AND THEIR PERFORMANCE IN MYSORE STATE

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History and Importance

Potato has attained paramount importance among the agricultural crops in the world, not only as a human food, but also as a source of prosperity. It is grown and esteemed as an article of food practically in all countries of the world and its abundant production in other countries exceeds that of wheat and rice combined. Of the food crops, it is the only one so universally eaten as to be considered as a staple food.

Regarding its home, scientists are agreed that the potato is indigenous to South America and that it probably originated in the Central Andean region. However, one group of scientists claim Chile as its original home whereas another group is inclined to regard Peru as the region from which it came. It is now grown in all parts of the world—the whole of Europe, the two Americas, Australia, parts of South-East Africa, Japan and Burma. It is seen that the Union of Soviet Socialistic Republics, Germany, Poland, France and U.S.A. are the five important countries in the world covering 75% of the acreage. It is said to have been introduced into Europe only in the latter part of the 16th century. If little is known regarding the early history of the potato in Europe, still less is known about its introduction and spread in India. It is possible that potato was brought to India by the Portuguese explorers who opened the trade route from Europe to India. According to Watt (1908), the first mention of the potato in India, occurs in Terry's account of the banquet at Ajmer given by Asaf Chan to Sir Thomas Roe in 1615.

Though potato is the most extensively cultivated of all vegetables in India, it is unfortunate that it has not yet received due recognition as an important food crop and has hitherto been regarded as a vegetable—a luxury chiefly for town dwellers. The area under potato in India is much smaller in comparison with other countries and is estimated at less than 1 per cent. of the world acreage. The quantity produced in this country is highly insufficient. In India, although the soil and climatic factors are suitable in most areas for potato cultivation, only about 0·2% of the total cropped area is under potato. Leaving aside the quantity required for seed purposes, about 8 lb. of potato are available annually per head, as against about 500 lb. per head per annum in some of the Western countries.

INCREASING POTATO PRODUCTION

It is not extensively grown in India though its paramount importance is realised because the main obstacles in the way of increased production are: (1) absence of different varieties suited to varying conditions of climate and soil in different parts of the country ; (2) non-availability of healthy seed in adequate quantity at the right time and at a reasonable price ; (3) the heavy toll taken by fungal, bacterial and virus diseases and insect pests ; and (4) lack of storage and marketing facilities. It is therefore necessary to focus our attention towards, (1) evolution of high-yielding potato varieties ; (2) production of disease-free seed ; (3) control of diseases and pests ; and (4) improvement of seed storage.

To achieve these objects by our own self-efforts, will take a long time and till then the other alternative is to introduce seed potatoes which are high-yielding, disease-resistant and possessing good keeping qualities, etc. Keeping this in mind, efforts were made to secure good varieties of potatoes for seed purposes from Holland. Even the existing varieties were once imported into India and in this connection it is as well to remember that private enterprise by Europeans residing in hill areas has played a great part in the introduction of foreign varieties.

INTRODUCTION OF DUTCH POTATOES

The Institute for Research on Varieties of Field Crops (I.V.R.O.), Wageningen (Holland), offered to supply free samples of Dutch seed potatoes for trial purposes. It is generally known that Netherlands has an excellent reputation as a supplier of bulbs and seed potatoes. Dutch potato has become a welcome guest in a great many countries and the Dutch are said to be potato experts. Dutch farmers are said to co-operate closely with scientists to improve and perfect the potato and so everything possible has been done to maintain and enhance the international reputation of Dutch potatoes. Further, the Dutch potatoes are strong and healthy, well-shaped, sound, clean, highly nutritious, of good colour and palatable. It is believed that Dutch climate is particularly suitable for seed potato growing. Again, only such of the seed tubers received from inspected fields in Netherlands and certified after harvest by the General Inspection Service (N. A. K.) are exported outside and this prevents to a very great extent the introduction of any new disease.

Realising the international reputation gained by the Dutch seed potatoes, the Department of Horticulture in Mysore accepted the samples offered by the I.V.R.O. Hitherto four consignments consisting of many varieties in small quantities have been received at various periods. A small quantity was grown each time at the Government Botanic Gardens, Lalbagh, Bangalore, and the remaining were distributed to the *ryots* for experimental cultivation.

In the following paragraphs some salient features of the varieties which are promising and their performance locally are given.

POTATO CULTURE IN MYSORE

Potato is mainly grown in the plains in Mysore State. Bangalore and Kolar Districts cover 90% of the potato acreage of the State. Hoskote, Anekal, Bangalore and Devanhalli in Bangalore District, Chikballapur, Sidlaghatta, Kolar and Malur in Kolar Districts are important potato areas. The rest of the potato areas are in Hassan, Chikmagalur and Tumkur Districts—Hassan being important among the three. The acreage under potato has steadily increased in Mysore State. It was about 4,400 acres during 1915-20 while the area under potato during 1952-53 is about 11,287 acres.

Potato is a crop which adapts to a wide and often diverse range of climatic conditions. Hardenburg (1926) has shown that soil type influences the shape of the tubers in that the lighter aerated soils produce tubers which more nearly approach the ideal shape or standard type than do the heavier soils. Further, it may also be stated that it is generally agreed that the type of the soil affects the cooking quality.

The choice of a variety for a given locality should be made on the basis of such factors as soil type, length of growing season and market preference. The distinctions used in classification are shape, colour of tubers, colour of sprouts and colour of flowers. In this connection it has to be remembered that attention has been drawn to an important fact, *viz.*, the influence of environment on the expression of the morphological characters. The potato is specially sensitive to changes in climate and under certain conditions some of the plant characters may be considerably modified or even completely suppressed.

POTATO VARIETIES IN MYSORE

Potato varieties in India are broadly divided both by farmers and trade into two sharply divided groups: (1) the *vilaaithy* (European varieties); and (2) the *desi* or the country varieties. Even some of the *desi* varieties probably represent the survivors of the earliest introductions because India is not the home of potatoes.

Till about a decade ago, the main varieties in Mysore were only two, *viz.*, Dharwar and Rickets. The characters of these varieties are as follows:

1. *Italian White Round.*—Syn. Karachiwala, Natu, Poona, Local Riccio (Italy), *Dharwar.*

This variety in pre-war days was extensively grown in Western India especially in Bombay, the Central Provinces, Mysore, Sind and in certain Central Indian States. The seed of this variety was obtained from time to time, from Southern Italy, where it is said to be widely grown under the name of Riccio. It is probably synonymous with the old English variety Brown Rocks. As this seed used to be obtained from Dharwar to Mysore, this is probably called Dharwar. It is said to be a hardy, high-yielding variety capable of withstanding a considerable amount of rough handling. With the stoppage of Italian seed supplies, this variety is being rapidly replaced by Simla variety, particularly, the *Numbri* or *Lumbri.*

The tubers of Riccio are of medium size, smooth skin, white colour, round shape, slightly irregular, very deep many eyes, the flesh colour being pale yellow. It yields moderately possessing good keeping and cooking qualities.

The distinctive characters of this variety are : erect, open habit ; thin, erect branches ; wrinkled leaflets ; abundant, drooping bunches of white flowers ; irregular, round, white tubers with deep eyes.

Now, this variety has almost disappeared from the areas owing to the stoppage of import of seed potatoes from Italy.

After the Second World War, Rickets or the Royal Kidney is gaining popularity.

2. *Royal Kidney.*—Syn. Lahleih ; Nainital, Phan Maurining, *Ricket.*

Tubers of Rickets are medium to large, smooth skin, white colour, cylindrical shape, often sharply narrowing down towards heel or crown, giving it a pear-shaped appearance, prominent eye brows, colour of the flesh being pale yellow.

The distinctive characters of this variety are : stem is weak, with spreading, open habit ; light yellow-green foliage with often light-coloured apical tufts of leaves ; practically no flowers and, if any are present, these are with malformed anthers ; white cylindrical tubers.

Royal Kidney is popularly known as Rickets in Mysore State because about a century ago one Mr. Rickets—a military officer in Mysore, obtained a few tubers of this variety and planted them in his backyard garden at Hoskote—14 miles away from Bangalore. He showed to the growers the excellent performance of this variety and the variety was taken up after his name.

Rickets is a little early taking about 2-3 weeks less than Dharwar but it is somewhat delicate requiring regular watering without any break. However, both these varieties, *viz.,* Dharwar and Rickets are considered to be short-duration varieties (3-3½ months). Rickets comes to harvest just three months after it is planted. Between the two, under Mysore conditions, it is said that

Dharwar is more resistant to diseases but Rickets is good when cooked. Its flesh has a sandy feeling whereas Dharwar becomes powdery. Rickets is preferred for early sowings, and Dharwar was being preferred for late sowings.

For some time, Rangoon Rickets from Burma during the beginning of the Second World War, gained popularity. This takes a week longer to come to harvest, but this has also disappeared from the market. Besides, Nilgiris also was supplying seed potatoes for South India. Largely, three varieties used to be supplied from Nilgiris: (1) Great Scot, which is a large round potato with several deep eyes; (2) the Mountain; and (3) the British Queen. Though they gave good yields, they were not cultivated in Mysore for a long time because they take a longer time and are prone to many diseases. Further, potatoes from Shillong, Darjeeling, Dehra Dun, Kalka, Simla, etc., were also tried. Except the Simla variety particularly the Numbri, the others did not yield good results and very often were a failure. So Mysore, at present, looks forward to Simla seeds as there is no other better alternative. Simla, though it does not give maximum satisfaction, is yet satisfactory to a very great extent. Of the Simla varieties, *Numbri* or the Up-to-date is most important.

3. *Up-To-Date.*—Syn. Bankigola; Factor; Fransisi gola; Gharwal; Gharud Lumbri; Long Keeper; Military; Murree white; Nainital; *Numbri*; Pahri; Rangoon; Rangoon Nainital; Serbagla; Sitbo; Talisman; Tomri.

It is popularly called Simla variety because the seed potatoes are supplied from Simla. Simla is an important centre for the supply of potato to the plains of India. Clustering round Simla are a number of hill stations especially those situated to the East, which send large quantities of potatoes to Simla where they are stored, sorted, packed and despatched. The produce pours into it during September to November, and part of December.

It is called *Numbri* variety because this variety appears to have been introduced and distributed by the Punjab Department of Agriculture under a type number. In due course the number itself was forgotten and the variety came to be known as *Numbri*, *i.e.*, a numbered variety or *Lumbri*.

However, it is one of the most important commercial varieties and is grown extensively in the hills specially of Northern India. It is an excellent yielder producing large-sized potatoes of good shape. The tubers are large in size, with smooth skin, white colour, cylindrical shape, flattened, both heel and crown bluntly rounded off, fleet eyes, long eyebrows, slightly curved and slightly marked, the flesh colour being dull white.

The distinctive characters of this variety are: upright habit, graceful yellow-green foliage, broad, ovate leaflets with highly pigmented axils, numerous, erect, compact bunches of red purple flowers with deeply notched stigmas, longer, often long and flattened, tubers of attractive size.

DUTCH VARIETIES TRIED IN MYSORE

Though the abovesaid varieties are under cultivation in Mysore State they are not completely satisfactory in the matter of suitability to both the rainy and winter seasons, yield, resistance to pests and diseases, keeping quality, etc. Therefore with the main object of introducing better varieties satisfying to a greater extent, the Horticultural Department accepted the offer of the I.V.R.O. to try the performance of the Dutch varieties of seed potatoes. In this connection, it must be particularly remembered that every variety is a compromise, a combination of good and bad qualities. The grower who wants to benefit from the advantage offered by a certain variety must also accept its shortcomings. The varieties hitherto received from Holland are: (1) Allerfruheste Gelbe; (2) Alpha; (3) Bintje; (4) Eigenheimer; (5) Erdgold; (6) Furore; (7) Industrie; (8) Meerlander; (9) Profijt; (10) Saskia; (11) Ultimus; (12) Voran; (13) Noordeling; (14) Eerstelling; and (15) Rode Eerstelling. Of the fifteen varieties, the following seem to be apparently promising but further extensive trials are necessary to prove their merits and demerits.

1. *Alpha.*—It is a late variety, keeps well and has a high yield and moderate starch content. Large, regular oval round tubers with light yellow flesh and rather shallow eyes. Foliage develops slowly in the beginning and is rather open, later robust and strong and covers the ground well.

2. *Bintje.*—Early ripening variety, light yellow fleshed which has taken an important place in many countries on account of its very good yield, very nicely formed tubers and excellent consumption quality. Large regular tubers, nicely oval and with very shallow eyes, little chats, particularly suitable for the preparation of chip potatoes. Foliage develops quickly, is robust stemmed and strong with large leaves; said to suffer very little from drought.

3. *Eigenheimer.*—Medium early variety, develops quickly and can be lifted early. A potato for consumption but deteriorates rapidly and is not very good for keeping; good yield and good starch content; said to be a good potato for fodder. Tubers numerous, yellow fleshed, oval, moderately deep-eyed, with fairly irregular shape. Foliage develops quickly and grows rather tall, has many shoots and rather small leaves. Covers the ground well. Holds its own because of the dependability of the crop.

4. *Erdgold.*—Medium late variety with very large light yellow fleshed tubers; gives a high yield but the starch content is low.

5. *Furore.*—A consumption potato which is medium late with light red skin ; good yield with favourable proportion between ware and chats. The light yellow-fleshed tubers are of good shape, oval-round and shallow-eyed. Consumption quality is good. It has achieved some increase in clay soils. Poor keeping quality. Not suitable to sandy soils. Foliage develops and covers the ground rather late ; medium high, small-leaved, red foliage.

6. *Meerlander.*—It is a consumption potato variety. Rather quickly sprouts during storage. The round-oval, yellow-fleshed tubers are better in shape and have shallow eyes. Less sensitive to drought. Foliage develops fairly early ; vigorous with large leaves and covers the soil well.

7. *Saskia.*—Very early to early variety. Tubers are large, well-formed, oval, shallow-eyed, light yellow-fleshed. The yield is higher in maturity, little chats. Foliage develops quickly, is strong, of medium height, large-leaved and covers the ground well.

8. *Ultimus.*—A medium-early to medium-late ripening potato for industrial use. It is said to be particularly suitable for damp soils. Good yield, fairly good starch content. The red-skinned yellow-fleshed varieties are fairly numerous and lie rather widely spread in the ground for which reason they are difficult to lift. The tubers are rather irregular, pointed oval in shape and moderately deep-eyed, sprout very early, though they keep fairly well otherwise.

All the Dutch varieties with one or two local varieties were tried both in summer and winter season. Regarding the cultural methods, those which are in common practice were adopted. However, intensive cultivation starting from the preparation of the land up to the harvesting was done. Planting was done by cut setts and the crop was irrigated by tank water. Necessary control measures were taken to check the pests and diseases.

Regarding yields, MacMillan (1935) feels that five tons per acre in the tropics may be considered a good return. This would be over twelve-fold. In Mysore State, an average yield is about ten times the seed-rate, the out-turn being about 9,000 lb. or 10 cartloads.

PERFORMANCE OF DUTCH POTATOES IN MYSORE

Both the original and acclimatised Dutch seed potatoes at Lalbagh used to be distributed to other interested growers and a small portion was used for cultivation at Lalbagh. The results achieved so far are given in the following paragraphs :

All together, 15 Dutch varieties were cultivated for four times at Lalbagh. The first and second trials during 1951-52 are not taken into account as the crop was spoiled owing to unavoidable circumstances. However, during January 1953 to April 1953, original seed potatoes received from I.V.R.O. was tried at Lalbagh. In this trial it was noticed that some of the Dutch varieties yielded more than the local variety as could be seen in the following table :

No.	Name of the variety	Average yield in Mds./acre	Seed rate in proportion to the yield
1	Saskia	891·8	1:22 (approx.)
2	Ultimus	808·9	1:20
3	Bintje	959·3	1:23 ,,
4	Eigenheimer	777·8	1:20 ,,
5	Furore	985·2	1:24 ,,
6	Erdgold	1016·3	1:26 ,,
7	*Local Numbri*	*679·2*	*1:17* ,,
8	Alpha	860·7	1:22 ,,
9	Meerlander	788·1	1:19 ,,
10	Profijt	829·6	1:20 ,,
11	Voran	316·3	1:75 ,,
12	Noordeling	544·0	1:13 ,,
13	Rode Eersteling	639·1	1:15 ,,
14	Eersteling	555·6	1:13 ,,
15	Allerfruheste Globe	751·8	1:18 ,,
16	Industrie	497·8	1:12 ,,

The varieties were planted in random arrangement in single plots without replications but they were harvested in subplots of 3 in each variety.

Noordeling, Eersteling and Rode-Eersteling were planted about 20 days later than the other varieties and the interpretation given by the Statisician for these three varieties is that varietal differences are not significant due to large variations within the plot and lack of sufficient number of replications. Regarding the other varieties, his interpretation is that Erdgold is significantly better than local variety, Voran and Industrie Furore, Bintje, Saskia and Profijt are significantly better than Industrie and Voran ; varieties like Ultimus, Meerlander and Eigenheimer are significantly better than Voran. Further varieties like Allerfruheste Gelbe and Local are significantly better than Voran. Therefore, the varietal differences are significant.

PERFORMANCE OF ACCLIMATISED DUTCH POTATOES

The tubers harvested in the above crop were rested for about 2½-3 months and the same were used for planting during the next season, *viz.*, July-August-September 1953. These once acclimatised seeds gave better results in the rainy season and the yields are as follows :

A glance therefore at the above figures show that there are many varieties which are better than the local varieties. Regarding pests, it is only Epilachna beetles that have been observed. In some of the cases, early blight was also noticed.

No.	Name of the variety	Seed rate in proportion to the yield
1	Profijt ..	1:29 (approx.)
2	Eigenheimer ..	1:55
3	Furore ..	1:28
4	Bintje ..	1:47
5	Erdgold ..	1:28
6	Alpha ..	1:30
7	Noordeling ..	1:20
8	Saskia ..	1:28
9	Rode-Eersteling ..	1:14
10	Meerlander ..	1:48
11	Ultimus ..	1:43·5
12	*Local Rickets* ..	*1:20*
13	Industrie ..	1:22·5
14	Eersteling ..	1:21·5
15	*Local-Simla Numbri* ..	*1:21*
16	Allerfruheste Gelbe ..	1:17

QUALITY OF DUTCH POTATO VARIETIES

However, in other respects also, the Dutch varieties seem to be favourable. Some of the Dutch varieties came to maturity earlier than the local varieties which contribute to a greater economy towards the cost of production. Further, regarding the early readiness of the variety for lifting—the earlier it can be lifted, the higher often the price which can be fetched for the product and the greater the chance generally of a successful second crop. The yield in most of the cases is higher and each Dutch tuber gives more sprouts per tuber and possesses a greater seed retentivity compared to that of local varieties. They stand longer in robust condition than local varieties. They are free from any disease such as ring formations, slushy pulp and bacterial affectations which are commonly found in local varieties. They offer a good sight as the formation of tubers are regular and some of them take a perfect oval egg-shape ; some are oblong. All the tubers are of uniform size and shape. They are much hardier than local varieties and has lesser content of water. Edible as they are, these tubers taste much sweeter and delicious and good cooking can be had of them in preference to local varieties. Knife gets through local varieties with ease as they are pulpy, while in the case of Dutch varieties, the knife goes harder with harder core. For the same volume, Dutch varieties weigh more than the local varieties owing to less water content. The seed potatoes preserve with greater ease and are not easily susceptible to pests and diseases. The percentage of rotting in the case of Dutch varieties does not exceed 3 while in the case of local varieties it is nearly 10. They have more number of eyes and give a higher number of sprouts and so lesser the seed-rate. The tubers are mostly uniform and the rejection for commercial purposes is only 2% while in the case of local varieties, it ranges up to 8%.

Whatever may be the preliminary results so far achieved, they are not conclusive. Further statistical trials during both the seasons in various regions are necessary to come to any definite conclusion. So, any variety cannot be recommended authoritatively for any region or season. Therefore it is felt necessary to procure some more consignments of seed potatoes from Holland and try their performance successively when we shall be in a definite position to give an opinion regarding the merits and demerits of each variety. In this connection, it is gratifying to note that the Government of India have opened a Research Station at Hebbal, Bangalore, for selection of potato varieties suited to Mysore. We hope, that substantial results will be forthcoming from the said Station.

OILSEED RESOURCES IN MYSORE

I. Introduced or Cultivated Oilseeds

BY K. GOPALA IYENGAR, M.SC.
Division of Economic Botany

THE State abounds in raw materials which form sources of oils and fats. This short note deals with plants which yield the so-called fixed oils, as distinguished from essential oils. Products of agriculture constitute the major bulk of the production. The present area under several oilseeds in the State is estimated to be 7,07,148 acres, and the production 1,45,000 tons of seed. This is apart from two other important sources of oil, coconut and cotton seed. The coconut produced in Mysore is either consumed locally or exported as edible ball copra. Very little is crushed. So also is hardly any cotton seed crushed. After meeting the local demand as feed for livestock, the surplus seed as such is exported. A small quantity of castor oil is obtained from perennial castors found semi-wild. *Honge*,[1] neem[2] and *mahua*[3] oils derived from tree growths are of some commercial significance. Besides these, there exist a host of other plants, whose value as a source of oil is realised, but not made use of very much due to one reason or other. Lack of a steady market, and attractive prices is one of the reasons for the non-exploitation of these oilseeds. The advent of cheap kerosene has practically killed the market for other oilseeds, whose oil was formerly used locally, as an illuminant. Allopathic drugs have stifled the use of many oilseeds and oils, formerly used freely for medical purposes. Abundant and cheap groundnut oil has displaced from use other minor edible oils. Lack of communications and cheap transport have also played their role in hampering a more extensive use than at present, of many oilseeds, collected as minor forest produce. The scattered nature of the trees also contribute to the difficulty of collection and in many cases makes it not worth the trouble.

Among the oilseeds derived from cultivation, groundnut is far and away the foremost. Next in importance are sesamum and castor. Together these three oilseeds account for more than 80%

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[1] Indian Beech : *Pongamia glabra* Vent.

[2] Margosa : *Azadirachta indica* A. Juss.

[3] *Hippe* : *Bassia latifolia* Roxb.—*Ed.*

of the area, and 90% of the production, in the State. Estimates of the area, and production, of several oilseeds in Mysore are :

Oilseed	Area in acres	Production in tons
Groundnut ..	4,42,833	1,27,191
Castor ..	85,937	11,533
Sesamum ..	64,913	4,993
Niger ..	5,500	385
Linseed ..	788	60
Rape and mustard ..	7,500	500
Miscellaneous ..	1,00,000	9,000

Groundnut, castor and sesamum, constitute what are termed as the major oilseeds. Recently, there has been a marked expansion of the area under groundnut and a contraction of the area under castor and sesamum. The following figures bear this out :

Period	Acres under		
	Sesamum	Castor	Groundnut
Average of 1929-30 to 1938-39	79,173	1,02,928	2,40,789
Current year (excluding Bellary)	60,089	79,986	2,90,204

The other oilseeds, apart from the above are known as minor oilseeds. Of these, niger and safflower are important. As in the case of sesamum and castor, there has been a steep fall in the area under niger, from the pre-war average of 16,234 acres. Again, substitution by cheaper groundnut oil has been responsible for this diminution of both area and production. The same holds good for safflower too, but reliable figures are lacking. Considerable amounts of safflower known as *Kardi* seed in trade, is imported from Sholapur and Hindupur for crushing locally. On a rough estimate, 50 tons of seed are crushed thus. The local production of linseed and poppy is found insufficient. Local trade obtains poppy seed from Sholapur and supplies of linseed are derived from Bombay Karnatak, Andhra and U.P. Normal imports amount to 360 tons of poppy seed and 120 tons of linseed annually. The classification Rape and Mustard is one of convenience and only mustard is raised in the State. The seeds are used as a condiment, and not crushed. There is a small surplus left over, after meeting internal requirements. Other sources of oil available from cultivation but not made use of at present are seeds of cucurbits, Deccan hemp, hemp, melons, soyabean, tea and tobacco.[4] As the uses of these oilseeds, oils and cakes are well known, they are not stressed upon. In conclusion it may be mentioned, that groundnut in its march of achieving the foremost position as an oilseed in Mysore, has remorselessly rendered other major oilseeds of less account, and reduced the value of many minor oilseeds to insignificance.

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[4] The uses of tobacco oil and cake are described in an earlier article in the Calendar.—*Ed.*

II. Oilseeds—Partly wild *&* wild

BY K. GOPALA IYENGAR, M.Sc. & K. S. KRISHNA SASTRY, M.Sc.

Division of Economic Botany

PERENNIAL or tree castors are common in backyards and waste places. The seeds are ground to a paste, and allowed to simmer with a large quantity of water over a slow fire. The oil that floats is removed. Formerly, this oil was highly esteemed for internal use, external application, and medicinal purposes. This mode of extraction is slowly dying out.

Of oilseeds and oils obtained from trees and wild sources, *honge, neem* and *mahua* are commercially important. About 3,000 tons of *honge* seed is crushed in a year, producing 900 tons of oil. *Neem* seed crushed amounts to 330 tons, resulting in 100 tons of oil. Approximately, 300 tons of *mahua* are consumed by mills, and 120 tons of oil produced. Exploitation of *dhupa*, candlenut, and wild *mangosteen* appears to hold out bright possibilities. Guga yields the wood oil of *malnads*. Wood of sandal yields the reputed sandal oil. Another introduced tree now common around Bangalore, yields an aromatic wood oil. This is linalœ, *Bursera dalpecheana*. At present, only the fruits are used in the production of oil. These and other plants of possible, and proved value are listed below in alphabetical order, along with brief notes against each species.

1. *Alangium salviifolium* (L.) Wang.—Alangiaceæ.—*Ankole* is a small deciduous tree of *maidan* tracts. The seeds contain sterol, but very little fatty oil.

2. *Aleurites moluccana* (L.) Willd.—Euphorbiaceæ.—Candle nut; Belgaum walnut—*Nadu akhrot*—a handsome, ever-green tree, of *ghat*[1] forests, not abundant in Mysore. The large seeds are poisonous, but edible when roasted. Seeds yield 60% of a dark oil, similar to tung oil in properties and uses. It can also be used in the manufacture of soaps. Cake is poisonous and cannot be fed to cattle, but can be used as a manure. This species deserves considerable dissemination in *malnad*.

3. *Anacardium occidentale* L.—Anacardiaceæ.—Cashew, or *geru* is a familiar, medium-sized, spreading, evergreen tree, found in many plantations and forests. The edible kernels yield an oil,

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[1] Western Ghats.

resembling almond oil. This oil is not extracted. During processing, when the nuts are roasted, the shell exudes an oil. This shell oil is a dark brown, viscous, liquid, and though lacking in glycerides is a drying oil. Local uses for the oil are in water-proofing, and as a preservative of fishing crafts and gear. The oil is capable of being used in the manufacture of a wide range of industrial products, and is extensively employed thus in U.S.A.

4. *Argemone mexicana* L.—Papaveraceæ.—Prickly poppy or *daturi* is an introduced weed very common. The seeds are poisonous, and contain over 20% of a nauseous, bitter, inedible oil. The oil can be used as an illuminant, lubricant, and for external application in skin ailments. It can be mixed with linseed oil in the manufacture of paints. The seeds often contaminate mustard, thus imparting poisonous properties to the latter, an edible oil. This contamination is said to cause serious epidemic dropsy. The cake is poisonous due to residual oil, and can be used as manure.

5. *Azadirachta indica* A. Juss.—Meliaceæ.—Margosa, *neem* or *bevu* is a familiar tree. The seed, oil and cake are familiar articles of commerce, and their uses are well known. The State crushes 330 tons of seed, and produces 100 tons of oil, a year. A more attractive price for the seed would result in greater production. It behoves of the soap industry to use this oil very freely, and release edible oils for consumption. Propagation in compact blocks should be encouraged to facilitate the collection of seeds. *Vanamahotsava* (Tree Planting Festival) should emphasise this valuable tree, particularly on black cotton soils.

6. *Balanites œgyptiaca* (L.) Delile—Simaroubaceæ.—*Ingala, Ingalika* is a small thorny tree of dry scrubs in *maidan*[2] parts. The seeds contain more than 40% of a bland, tasteless, yellow oil, suitable for making soaps.

7. *Buchnania lanzan* Spreng.—Anacardiaceæ.—*Lanzan murkal.* —This and the similar *B. angustifolia* Roxb. the Cuddapah almond or *muradi* are small trees of dry scrubs and *hills. Nurkal* is also found in *malnad*. The edible kernels are eaten both raw and roasted, and is employed in the preparation of sweets and confectionery. The kernels contain 50% of a yellow oil, similar to that of almonds. Little oil is extracted, since the kernels are consumed as such. Both species are highly useful in clothing, dry, arid, rocky wastes.

8. *Calophyllum inophyllum* L.—Guttiferæ.—Alexandrian laurel, Pinnay—*Honne, surahonne.*—A medium-sized, handsome, evergreen tree of *ghat* forests, often planted on account of the fragrant flowers. The round seeds yield more than half by weight, a bottle green, heavy, evil-smelling oil, known in trade variously as laurel, pinnay, or poon seed oil. The oil is of excellent quality for soap-making, but of no culinary use. It is used as an illuminant, and in the treatment of rheumatism and leprosy. Cake is a

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[2] Open region as distinct from *malnad*, hilly region.—*Ed.*

manure. *Malnad* and semi-*malnad* should be able to provide a large amount of oil, for purposes of soap manufacture.

Oil of a similar nature is to be had from species of *C. apetalum* Willd., *C. elatum* Bedd., and *C. walkeri* Wight. These trees are indigenous to *malnad*, and provide a useful lamp oil.

9. *Capparis grandis* L.—Capparidaceæ.—*Revapi* is a small tree of dry places, whose seeds yield an oil mainly used as an illuminant.

10. *Celastrus paniculatus* Willd.—Celastraceæ.—*Kariganne* is a scandent shrub of low hills and scrubs, whose seeds and oil are commonly traded by local druggists. The thick, reddish yellow oil, is a bitter, laxative, emetic and tonic.

11. *Cinnamomum zeylanicum* Breyn.—Lauraceæ.—Cinnamon —*Dalchinni, Lavanga patte.*—A large tree of ghat forests and along river banks in semi-*malnad*. Both the bark and the leaves yield a highly aromatic oil. Some leaf oil is distilled in Shimoga forests. A medicinal, fatty oil is obtained from the fruits.

12. *Cochlospermum religiosum* (L.) Alston—Cochlospermaceæ: Silk cotton—*Arasina buruga, Kadu burga.*—A small, deciduous, soft-wooded tree, with palmate leaves, and bright yellow showy flower, common in dry places. The floss is used for stuffing cushions and mattresses. The seeds contain over 16% of a pale yellow, inedible, non-drying oil, which can be used for the manufacture of soaps. The cake can be used as manure.

13. *Croton sparsiflorus* Morong—Euphorbiaceæ.—*Bedhi soppu*, a South American herb, has now become a common weed. The small seeds contain about 40% oil, with satisfactory drying properties. The cake cannot be fed to livestock, and can be used as manure.

14. *Croton tiglium* L.—Euphorbiaceæ.—The purging croton or *Japala* is not common in the State, but is sometimes found planted. The seeds yield the familiar medicinal oil, whose virtues and uses are widely known. The plant can be usefully introduced into dry forests, and the seeds collected as a minor forest produce.

15. *Diospyros peregrina* Gurke—Ebenaceæ.—*Holetumbra* is a medium-sized, evergreen tree of sholas and stream banks in *malnad*. Oil extracted from the seed is used in medicine.

16. *Dipterocarpus indicus* Bedd.—Dipterocarpaceæ.—Wood oil tree of S. India—*Guga, Yenne mara.*—A lofty, evergreen tree of *ghat* forests, which yields a resinous oil from borings made into the wood. The oil is used in the manufacture of paints and varnishes, but very little is collected in Mysore.

17. *Erythroxylon monogynum* Roxb.—Erythroxylaceæ.—The bastard sandal, *devadari*, is a small common tree of dry scrubs and jungles. On heating, the wood yields an oil resembling fat, which is used as a preservative by indigenous fishing craft.

18. *Garcinia indica* Chois—Guttiferæ.—The wild mangosteen, *mugal* or *murkal* is not very common in Mysore. This small, slender tree, with drooping branches is sometimes frequent near hamlets in the *ghat* forests of Chickmagalur. The seeds contain 20-25% of an edible fat, which is locally extracted in a manner similar to that from perennial castors. The greasy, whitish fat, is known in trade as *Kokum* butter and is frequently used to adulterate *ghee*.[3] The chief constituents of the fat are stearic, myristic, and oleic acids. The fat is used in the preparation of unguents and ointments. The rancid product can be employed as an illuminant or in the manufacture of soaps.

The *gamboge* butter is derived from the seeds of the allied *G. morella* Desr. *ardala* or *kankutuka*. This is a fairly common medium-sized tree of *ghat* forests, also the source of a dye *gamboge*, extensively used formerly to dye silk. There used to be a considerable extraction of this edible fat in the western districts of the State, freely used by the poorer classes. Fat that has turned rancid is used as an illuminant. An extensive regeneration of these *malnad* species, and commercial extraction of fat, appears to be worth pursuing.

19. *Givotia rottleriformis* Griff.—Euphorbiaceæ.—*Bhudi thale* or *Pulike* is a small tree of striking appearance with cordate leaves. It is frequent in the hill jungles of the eastern border, the seeds yielding a high quality lubricating oil.

20. *Holoptelea integrifolia* Planch—Ulmaceæ.—The *Thapsi* is a very large deciduous tree of semi-*malnad*. The seeds contain an oil which is rarely extracted.

21. *Hydnocarpus laurifolia* (Denn.) Slenmer—Flacourtiaceæ.—*Halape* or *toratti* and the allied *H. alpina* Wight, are large evergreen trees of *ghat* forests, found in the extreme western borders. They are the source of the famous *Chaulmugra* oil used in the treatment of leprosy and in the manufacture of medicated soaps. The inaccessible situations in which the tree is found has prevented any considerable local use of the seed. The seeds are a regular commodity in the oil markets in the West Coast. The oil is also employed for purposes of illumination.

22. *Jatropha curcas* L.—Euphorbiaceæ.—Physic nut—*Turuka haralu, Kadu haralu.*—This and the allied *J. glandulifera* Roxb.—*Hari turuka haralu* are natives of tropical America, but are now common as shrubs of dry wastes, and *maidan* jungles. The seeds resemble those of castor, and contain over 30% of a yellow reddish oil with an unpleasant smell. The oil is sometimes miscalled as croton oil. The chief constituents are oleic and linoleic acids. The oil is a purgative, emetic and also used in case of cutaneous disorders, and as an illuminant. Soap can also be made out of this. The oil of *J. glandulifera* is not administered internally, and is frequently used in the treatment of paralysis and rheumatism.

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[3] Clarified butter.

23. *Litsœa chinensis* Lam.—Lauraceæ.—*Lakki* and the similar *L. zeylanica* C. & Fr. Nees are moderate-sized, evergreen trees of *malnad* forests. The seeds contain about 50% of fat rich in lauric acid, used locally as an illuminant, and in the treatment of rheumatism.

24. *Madhuca latifolia* (Roxb.) Macbr.—Sapotaceæ.—*Mahua—Kadu ippe.*—This and the allied *M. longifolia* (L.) Macbr. *K. ippe* and *M. malabarica* (Bedd.) R. N. Parker—*hole ippe*, are more familiar as species of *Bassia* and are the source of the well-known *mahua* fat or oil. Though *M. latifolia* is commercially more important in Mysore, *M. longifolia* is more common being frequently seen in plantations and avenues. *Hole ippe* is a small tree common along water courses in *malnad* and Mysore District. The seeds contain 50% of fat, whose chief constituent is palmitic acid. The whitish yellow fat, has a pungent aroma, and a slightly bitter taste. The oil is a culinary oil, is used to adulterate *ghee*, an illuminant, and used in the manufacture of soaps and candles. Local crushings amount to 300 tons of seed a year and oil produced is 120 tons. The cake can be fed to cattle and used as a manure. Weedicide virtue is sometimes attributed to the cake, when applied to lawns. This oil source deserves to be established on a secure basis and the trees need considerably more dissemination.

25. *Mimusops elengi* L.—Sapotaceæ.—*Pagade* or *ranja* is a large, handsome, evergreen tree, of *malnads*, often cultivated on account of its fragrant flowers, and edible fruits. The seeds furnish a culinary and medicinal oil.

26. *Moringa oleifera* Lamk.—Moringaceæ.—The drumstick or *nugge* is a small tree more frequent in cultivation than wild. The pods furnish a highly appreciated vegetable and no seed is crushed. The seeds contain nearly 35% of a clear, limpid, transparent, edible oil known as *ben* oil. The perfume industry sometimes uses this oil. The quality and virtues attributed to this as a lubricating oil, appears to be not sound.

27. *Myristica malabarica* Lamk.—Myristicaceæ.—*Rampatre* is a moderate-sized tree of *malnads*, whose seeds yield 40% of a yellowish fatty oil, used in medicine, and as an illuminant.

28. *Pongamia pinnata* Pierre.—Leguminosæ.—The Indian beech or *honge* is a familiar tree, common both wild and in cultivation. It is a minor forest produce in many divisions of the State forests. Local production is supplemented by imports from other parts of Karnatak situated in Bombay, Madras and Hyderabad. Annually, about 3,000 tons of seed are crushed in Mysore, resulting in 900 tons of oil. Bangalore is a recognised centre of trade for seeds, oil and cake. The seed is regularly quoted in the local market, and currently fetches Rs. 60-62 for a unit of 250 seers. Seeds contain 30-35% of oil. The uses of the tree, oil and cake are well known. Industry should absorb larger quantities of the oil, than at present. All afforestation and regeneration measures, should employ

this species largely. The tree should also be made an obligatory constituent of the *Vanamahotsava* drive.

29. *Santalum album* L.—Santalaceæ.—Sandal, or *sreegandha* yields an oil from the seeds, apart from the famous oil derived from the wood. Renewed investigations into the process of extraction are worthwhile since previous attempts are reported to have been frustrated by the presence of resinous matter.

30. *Samadera indica* Gærtn.—Simarubaceæ.—The seeds of this small tree of *malnads* acts as an emetic. The oil from the seeds is supposed to be of value in the treatment of rheumatism, and is also used as an illuminant.

31. *Schleichera oleosa* (Lour.) Merr.—Sapindaceæ.—The Ceylon oak, or *Kendala* is a large, handsome tree of *malnad* and Mysore District, with a thick canopy. The edible seeds yield 60% of a culinary oil. The oil is an illuminant, can be used for the preparation of soaps, in the treatment of skin afflictions, and as an ingredient of hair oils. In trade, the oil is known as macassor or *Kusum* oil.

32. *Stereospermum xylocarpa* K. Schum.—Bignoniaceæ.—The *Konanakombu* is a large tree of *malnads*. On distillation, the wood yields a thick resinous fluid resembling Stekholm Tar, used in the treatment of skin eruptions.

33. *Terminalia catappa* L.—Combretaceæ.—The Indian almond, or *jungli badami* and the related *T. procera* Roxb. are tall deciduous trees with whorled branches, and large leaves. The edible seeds, yield 50% of oil, similar to that of almonds. The trees are frequent in cultivation and are not wild.

34. *Vateria indica* L.—Dipterocarpaceæ.—The Indian Copal, or *dhupa* is a large, evergreen tree, of *malnad* forests, bearing large, three-valved capsules. The wood yields a resinous fluid, employed in the manufacture of paints and varnishes. The seeds contain 20-25% of a greenish yellow fat, which turns whitish later on. The fat is edible and has no marked taste or smell. It is frequently used to adulterate ghee, as an illuminant, and for rheumatic complaints. In trade, this is known as Malabar tallow, pinney tallow or *dhupa* fat. It provides an excellent substitute for animal tallows, particularly in the manufacture of soaps. The species deserves wider propagation and more intense exploitation.

PLANTING AND AFTER-CARE OF COCONUT SEEDLINGS

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COCONUT being a long-lived crop, it pays handsomely to exercise great care in the choice of seedlings and the method of planting them out. Seedlings used for planting are usually of two age groups. In the first group, seedlings are about an year old, and the seednuts remain entire and are still attached to the shoots. The second type of seedlings are nearly three-years-old, the seednuts will have decayed and the shoots will have established themselves on their own root systems. These older seedlings are locally known as *Geppe*. The choice of each group with its attendant advantages and disadvantages have been dealt with by A. K. Yegna Narayan Aiyer in his *Field Crops of India.*

Nurseries supplying quality seedlings, are being jointly run in the State by the Indian Central Coconut Committee and our Government. At present, three such nurseries exist in Mysore. One is located on the Central Farm, Hebbal, near Bangalore. A second nursery is run on the Experimental Farm, Babbur, near Hiriyur. The third nursery is situated on the Visvesvaraya Canal Farm near Mandya. Annually, at each of these nurseries, nearly 8,000 seednuts are planted. Approximately, 5,000 quality seedlings become available for distribution from each nursery every year. These nurseries supply only one-year-old seedlings. Seedlings will be had during the period June to September. The method of planting these seedlings and looking after them subsequently, is briefly dealt with in this note.

Planting should conform to local conditions of climate and soil. The major area under this crop in the State is cultivated dry, as in the districts of Tumkur, Hassan, and portions of Chitaldrug, and Chickmagalur. Here, rainfall being the only source of moisture for the palms, the seedlings should be planted deep so that their roots may penetrate deep into the soil. Thus a better use of the soil moisture is secured resulting in more survivals and firmer anchorage for the palms. Preparing pits, and deep planting of seedlings should be done as follows :

After selecting a suitable plot which is fairly level, pits should be dug with the dimensions of 3 × 3 × 3½′. A spacing of 33′ bothways from the centre of the pits should be provided. This will give 40 palms to an acre. The pits should be dug by April or May and the sides charred by burning trash and dry refuse and allowed to weather. Later the bottom of the pits should be stirred well and all the unburnt matter removed, lest they attract white ants. After this, a mixture of pure sand and rubble should be filled to a depth of about 1′ from the bottom. This will provide for easy percolation of rain and adequate drainage. Of the remaining 2½′ in each pit, 2′ should be filled up with a mixture of clean red earth and sand, leaving the top 6″ of the pits clear.

Seedlings should be planted in the centre of these pits by about June or July. The mother nut of the seedlings should be just below the soil surface inside the pit, which by itself is 6″ below the ground level. The soil inside the pit should be made in the form of a mound sloping away from the middle towards the sides. This mound ensures that the excess of water which might otherwise accumulate in the pits either due to heavy rainfall or due to copious watering, will drain away to the sides of the pit, preventing the rotting of the seedlings at the collar. If the pits get filled up completely due to heavy rains, the excess of water should be removed as early as possible, by bailing out. A rough sketch of the prepared pit and the planted seedling is given at the end. To prevent attack of white ants, 3 oz. of Gammexane should be sprinkled round each mother nut at the time of planting the seedlings.

After-care.—One month after planting, 2 oz. of ammonium sulphate at a time, may be given three times, at intervals of 1 month each. This should as far as possible be done only during the beginning of rains, in the absence of which the seedlings should be watered well. The application of ammonium sulphate will increase the vigour of the plants. The interspaces between the seedlings may be used for the cultivation of *hurali*,[1] *togari*[2] or other leguminous crops.

With the beginning of *mungar*[3] rains in the second year, add about 4 lb. of ash and 1 lb. of bonemeal to each pit and stir the soil well. A month after this, 4 oz. of ammonium sulphate should be applied thrice, at intervals of 1 month each. At the close of the monsoon, the sides of the pit should be trimmed, and the soil round each seedling should be lightly dug and a fine mulch created, to prevent the evaporation of soil moisture.

At the start of the third *mungar* rains each seedling should be given a dose of 10 lb. of ash and 2 lb. of bonemeal. A month later 8 oz. of ammonium sulphate should be given to each plant four times, with an interval of 30-40 days between each application, when there are good rains. By the end of the monsoon, the soil round about and in between the seedlings should be ploughed or dug well and a fine tilth created. From the fourth year onwards, growing of green manures, and application of cattle manure during the monsoon should be done regularly, and the land well cultivated. If these operations are done efficiently and in time, the seedlings will grow vigorously and will start bearing from the seventh or the eighth year. Economic bearing can be expected from the fifteenth year onwards.

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[1] Horsegram.

[2] Pigeon pea (*Cajanus cajan*).

[3] Early rains in April or May.

The two important points to be borne in mind for establishing the seedlings successfully in the plots are to prevent water-logging during monsoon, and conservation of moisture during summer.

In the irrigated and riparian tracts, which are likely to get flooded during rains, the seedlings should not be planted deep. In plots having adequate drainage, the seedlings may be planted in pits 3′ cube, with a spacing of 30′ from the centre of the pit bothways. This spacing will result in 48 palms to an acre. These pits should be filled with 6″ of sand and rubble at the bottom, and 2′ of red earth and sand above. The surface inside the pit will be 6″ below the ground level, and on this, selected seedlings may be planted as described previously, either during *mungar* rains or just at the start of the *hingar* rains. If the pits are likely to get waterlogged they should be filled right up to the brim with red earth and sand ; rubble at the bottom in these pits should be 1′ in depth : and seedlings planted at ground level. Surface drains should be provided between rows to draw off excess of water. In this case the mother nut of the seedlings will be just below the ground level. As regards after-care of the seedlings, the previous schedule may be followed.

PROCESSING OF ARECANUTS

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PROCESSING and curing of tender arecanuts is an essential operation to reduce the high tannin content and to improve their keeping quality. Ripe arecanuts are dried and sold while tender ones are sliced, boiled and dried. Arecanuts contain tannin to a larger extent which gets reduced in the process of ripening and curing. Curing operations vary from place to place.

In certain parts, such as South Kanara, Travancore, Assam, etc., arecanuts are harvested while they are fully ripe, dried well, husked and sold. In Sirsi, Siddapur and Kumta, nuts are harvested when they are partially mature, then husked, boiled and dried. In Mysore, Cochin and South Malabar, tender nuts are harvested, husked, sliced, boiled and dried and then sold as different varieties of *Kalipak*.

PROCESSING OF TENDER NUTS

Since tender nuts are highly perishable, all the operations from husking to boiling have to be done as expeditiously as possible, lest they should get deteriorated. After husking the tender nuts, they are sliced according to the requirements of the markets, then boiled with water in large copper pans. The exact stage at which boiling has to be stopped is determined in each case by experience. The boiled slices are removed by bamboo laddles. After removing the slices, optimum quantity of water is added and a second charge of nuts is added and boiled. In some cases, it is also the practice to use for the first charge water in which various barks, roots and other materials which impart a deep brown colour to the nuts have been boiled. The general practice is to boil 8 *thulams* (1 *thulam* = 37½ lb.) of sliced nuts in 60 gallons of water at each charge.

The decoction remaining after boiling the second charge is transferred to a cooling vat and is allowed to settle for about 24 hours. The clear supernatant liquid which will be roughly about 50 gallons is again boiled for about 3-6 hours into a syrupy deep red viscous matter which yields about 4 gallons of *Kali* or *Chogaru*.

Good uniform colour and gloss fetches a higher price for the finished product. For a single colouring, about 4 gallons of *Kali* is used for about 10-15 *thulams* of raw boiled nuts. For very deep colouring, it is repeated once again. About 1 gallon of *Kali* is sufficient for 10-15 *thulams* of raw boiled nuts to impart light colouring. To give shine to the finished product, a few ounces of gingelly or coconut oil is also added. To improve colour and for preventing excess removal of tannin, various organic and inorganic materials are used. Colouring also increases the weight of the material from 10 to 35%.

Drying the coloured nuts should be done uniformly. Drying in the open under the sun would be the best and cheapest. In *malnad* areas of Mysore and South Kanara, high *pandals* (platforms) are erected about 12-15′ high, covered with split areca stems and mats. The drying mats are strong bamboo mats made in sizes 8′ × 4′ of which six are required to handle a charge yielding 50 lb. During rainy weather, artificial drying has to be resorted to. This is done on a specially devised masonry furnace costing Rs. 250 to Rs. 300 and capable of drying 8-10 *thulams* at a time.

In West Bengal nuts are harvested when ripe and preserved in pits and used in the off season. In Assam people use uncured, mature and immature nuts. For use in the off season, nuts are preserved in pits or in water.

CULTIVATION OF PAPAYA

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PAPAYA is indigenous to tropical America but now grown practically in almost all the tropical and sub-tropical countries of the world. It is one of the most important fruits in Hawaii, Malaya, Burma, Ceylon and India. It is believed to have been introduced into India in the sixteenth century from Malacca and it is now grown on a large scale in the States of Bihar (about 5,750 acres), Bombay (about 2,071 acres), Uttar Pradesh (about 672 acres), Bengal, Andhra, Madras and Mysore. The acreage under papaya in South India is estimated to be over 1,000 acres of which about 100 acres are in Mysore State, the main areas being Bangalore and Mysore Districts.

The cultivation of papaya has a special appeal to the growers for various reasons. Like Banana it comes to bearing in about an year. It is a high yielder, capable of producing over 10,000 lb. of edible fruit per acre in a year and the fruit is prized for its sweet and agreeable taste and for its high vitamin A and C contents. An enzyme called *papain* is prepared from the papaya juice. Its use as a cholera bacteriophage was found very valuable during the cholera epidemic of 1943-44 in South India. Papaya is highly adaptable to a diversity of soil and climatic conditions rendering its culture easy. It is practically free from any serious pests and diseases. Almost every part of the tree from the root to the fruit is used for medicinal purposes in different countries of the world. Since it occupies very little space, it can be grown in any garden, large or small. A tree with such merits is naturally bound to become popular.

SOIL AND CLIMATE

Papaya is tropical in its climatic requirements but adapts itself to a wide range of territory and can thrive up to an elevation of about 4,000′. It is highly susceptible to frost and shelter from high winds is absolutely necessary. Though best performance is seen on rich loams of uniform texture for about 6′, papaya will grow in almost any kind of soil provided there is perfect drainage. Under, water-logged conditions, it is liable to die either by over-saturation at the root zone or by collar rot. Generally under such conditions the foliage turns yellow and the lower leaves drop off and the plant presents a lanky appearance.

VARIETIES

There are no fixed varieties because the flowers are cross-pollinated and therefore seeds cannot be relied upon to reproduce the parental characters in all the progenies. However, due to continuous selection, the so-called "varieties" known as Washington, Honey Dew, Bangalore, are popular in Mysore State and other parts of South India. The fruits of Bangalore variety are long and broad at the apical region and have a distinct but not too prominent a beak. Colour of the fruit when ripe is yellow; flesh is reddish yellow and has a sweet taste. Average weight is about 4 lb. The Honey Dew variety is round when ripe and has a prominent beak. Colour of the fruit is reddish yellow. Taste is very sweet. Average weight is about 4·8 lb. The fruit of Washington variety is of small size comparatively and round in shape. Fruit is yellow when ripe and colour of the flesh is saffron. Average weight is about 3 lb. Taste is quite sweet with a distinct good flavour.

PROPAGATION

Papaya is universally propagated by seeds. Vegetative propagation by grafting and cutting is found to be possible but the plants thus propagated are very uneconomical in view of the short life of the plantation. Besides, the plants seem to lack vigour and bear poorer fruits than parents. Seedlings may show variable performance as papaya is cross-pollinated but a wise selection of seeds will, to a certain extent, ensure fairly good fruits. Seeds should always be selected from fruits of good size and shape and of thick and very sweet flesh produced by vigorous and profusely bearing trees. They should be extracted from fruit only when they are fully ripe and then washed to remove the gelatinous pulpy covering matter adhering to them and then dried under shade. Though seeds can retain viability for nearly an year if they are preserved in clean, air-tight bottles, maximum germination can be secured by using them soon after they are extracted. Sowing of seeds without washing off the gelatinous pulpy matter is recommended by some. Best time to raise seedlings is the monsoon period from June to October or November though it can be done at any part of the year except during the hottest, rainiest and coldest periods. About 8 oz. of seed will be sufficient to raise the trees for 1 acre.

SEED SOWING

Papaya plantation can be raised either by sowing seeds *in situ* or by transplanting seedlings. The former is a very expensive method as it involves lot of labour for watering, weeding and tending the plants which are distributed in the far larger area whereas raising seedlings in beds is very easy since all of them are in one place. Besides it is said that seedlings raised *in situ* take more time for flowering and the fruits borne by them are smaller than that of the transplanted trees. Therefore raising of the plantation by transplantation is preferred.

The site for the preparation of beds should be dug and left fallow for some time to make it friable. Then it is levelled and beds of 6′ × 3′ or any other convenient size are made. A mixture of tank or river silt, cattle manure and leaf-mould is spread over the bed to a depth of about 3″ and the surface is levelled. Seeds are sown about ½″ deep, 3-4″ apart in the row and 8-9″ between the rows. They are then covered with soil with a thin layer of sand to avoid formation of hard crust on the surface. The bed is watered immediately afterwards and then continued regularly everyday. Shade should be provided to protect the seedlings from heavy rains and severe sun by covering the bed with thatch. Seeds germinate in about 3-6 weeks. When seedlings have attained about 6-9″ which they will do in about 70 days after sowing, they are ready to be transplanted.

PLANTING

The land for the orchard should be ploughed and harrowed until good tilth is obtained. The size of the pits to be dug for planting varies with the soil. If the soil be rich and of uniform texture, 2′ cube pits or even of lesser dimensions would be enough. Otherwise 3′ cube pits are advisable. They are dug 8′ apart either way. The pits should be kept exposed for several days. Then the pits are filled up with surface soil mixed with well-rotten farmyard manure at the rate of 80-100 lb. per pit.

Papaya presents a great problem in the plantation as most of them may turn out to be either male or hermaphrodite types and determining the sex of plants before flowering and the elimination of the uneconomical plants has not been possible in spite of several experiments conducted in this direction. The most practical method appears to be to plant 3 or 4 seedlings per pit and when they have flowered one female plant is retained for each pit and one male for 10-20 female plants to provide pollen and the rest are grubbed out.

Three or four days before lifting the seedlings, most of the leaves should be clipped off. Unless lifting operation is preceded by good rain the bed should be thoroughly watered. Then the seedlings are lifted carefully with a ball of earth around the roots and planted in the pits. Transplanting should be done only during cool hours or in rainy weather. Immediately after planting they should be watered. It is necessary to protect the seedlings from sun by placing around them few leafy twigs until they have become established. As soon as the plants flower, one female tree is retained per pit and the rest are grubbed, keeping in view of the required proportion between male and female trees in the plantation as already stated. A strong windbreak should be raised well ahead of planting.

IRRIGATION AND MANURING

Papaya requires regular watering except in rains to produce good fruits. Whenever the first 6″ layer of soil is found to be dry, irrigation may be considered necessary. Excess moisture at the roots is harmful. As prolonged contact of stem with water favours collar-rot, basins should be made to slope away from the trunk gently. In several places plants are irrigated with sewage effluent and good crops are harvested. Papaya is a gross feeder. Commonly 20 lb. of farmyard manure is applied at the time of transplanting seedlings. If the soil be rich and pits are already manured, manuring is not necessary at the time of transplanting. The second dose is applied at the rate of 80-100 lb. of well-rotten farmyard manure just before the appearance of the flowers. The same amount of manure may be given in the successive years before monsoons. At several places, good crops have been raised entirely with sewage effluents.

INTER-CROPPING AND INTER-CULTIVATION

During the first few months after planting, vegetables like chillies, onions, tomatoes can be grown in the space between the trees. In many places, papaya itself is grown as an inter-crop in big orchards of guava, mango, sapota, coconut or litchi during the pre-bearing stage of the main trees. In papaya plantation, deep cultivation of the soil between the plants should be avoided as papaya is shallow-rooted. Hoeing of basins with hand tools or shallow intercultivation is necessary to keep down weeds.

PRUNING

There is little pruning in papaya. When the tree has borne fruits for 2-3 years and has grown tall it is advisable to headback the stem for the side shoots to grow and form new tops at lower level so that fruits may be easily harvested. An earthen pot should be placed inverted over the cut stem so that rain water may not enter inside the stem cavity. Thinning of fruits is necessary if they are overcrowded to allow them to attain their normal size and quality. Fruits are generally overcrowded in old trees where the internodes are shorter because the growth of the trees is less vigorous.

HARVESTING

The plants flower in about 6 months from the time of planting and it takes about 5-6 months for the fruits to be ready for harvest. Papaya produces fruits all the year round except in colder seasons. However the peak season is from March to May. When the rind of the fruit has turned yellow, they are considered to be ready for harvest. If they are allowed to mature on the tree further they are likely to be damaged by birds. Fruits harvested before maturity tend to lack in sweetness.

Though papaya plants live for 10-15 years it is uneconomical to retain them after 4-5 years as they cease to produce fruits of good quality and size. Besides, the trees are likely to be lost by disease or by accident. The yield has been different in different parts of the country. It ranges from 30-150 fruits per tree in a normal plantation, each fruit weighing from 1-6 lb. The yield per acre may work out from 30,000-60,000 lb. for the first three years of plantation. At Hessarghatta,[1] the yield from an acre is reported to be 13,000 fruits weighing about 43,500 lb. Sankaran states that yields ranging from 54,000-72,000 lb. have been recorded in Godavari District.

DISEASES

There are no serious diseases of papaya in our country but mention may be made of the following two which can be controlled easily.

Collar-Rot.—The portion of the stem near the ground begins to show symptoms of water-soaked appearance and is soft to touch. Gradually it spreads and bark is seen to split and a foul-smelling liquid oozes out. The tissues break rapidly and finally the tree falls down. The causal organism is said to be *Pythium* which is a soil-dwelling fungus. In the initial stages the affected part should be cut out and smeared with coal tar. In advanced conditions the plants should be removed and destroyed and their place left vacant for sometime. Poor drainage is said to foster this disease.

Ripe-Rot.—This disease affects the fruits. It appears as a whitish yellow patch on the rind which soon turns into light brown colour and begins to spread as a result of which the first of the fruit is affected and begins to shrink and produces folds in that region. The fungus is found to attack leaf-stalk as well as the stem of the plant. Control of this disease may be secured by spraying Bordeaux mixture.

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[1] Fruit Research Station.

ENSURING QUALITY IN COFFEE

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It is a universal truth that a quality product always sells. Mass produced articles, cheap in price but of low quality, may sell very well for some time but when there is an excess of supply over demand, it is the quality product that moves easily. So it is with coffee too. Indian coffee has established a name for itself in the world markets. Other coffee-growing countries of the world are competing for this position.

What constitutes quality in coffee ? A cup of fine coffee should have a fine aroma, good acidity and body and be clean. Most people are familiar with the aroma of coffee and it is not possible to describe it adequately. Acidity is the tingling sensation that one feels on the tongue and the lips and the gums when coffee infusion is drawn between the lips into the mouth. Body is that feeling of thickness that one feels on the tongue when a coffee infusion is rolled on it. How then can these be assured in coffee ?

The two commercial varieties of coffee that are largely marketed in India are *arabica* and *robusta*. *Arabica* coffee inherently has fine aroma, good acidity and good body. *Robusta* does not possess such fine aroma as *arabica*, has acidity but of a harsher type and possesses better body. The average annual production in India for the six years preceding 1953-54 of *arabica* is 16,000 tons and of *robusta* 6,000 tons. While one cannot add to quality already present or not present, it is possible to maintain the inherent quality and remove the bad characters which either mask or detract from quality.

Quality is affected to some extent by the cultivation done. A well cultivated coffee can be expected to give a better quality product than that which is indifferently cultivated. Well regulated shade provides the proper amount of photosynthesis, so that carbohydrate manufacture is maximum. With good supply of carbohydrates, the physiological activity of the plant is at its optimum and, therefore, correct amounts of plant nutrients are taken up to mature the fruit well. Die-back which is caused mostly by carbohydrate deficiency, produces bad coffee which on drying has a withered appearance and gives rise to what are called 'stinkers' in the cup. Shade prevents great variations in temperature, helps in maintaining moisture in the soil so that the berry matures gradually and ripens properly. Next in the order of cultural practices that ensure quality is the operation of weeding and removing of suckers. Weeds grow luxuriantly in coffee estates unless the plants have so overgrown each other that they shadow the ground completely when weed growth is inhibited. Timely removal of weeds and burying them under the coffee plants not only increases the humus in the soil, but leaves the field free and without competition for the coffee plant to absorb nutrients. Timely removal of suckers ensures the proper canalising of the plant nutrients and their flow into branches on which the berries grow.

Coffee plants have to be supplied with adequate amounts of plant nutrients, so that the physiological processes are carried out properly. It has been found by analysis of the leaf, blossom, berry and fruit of the coffee plant that it takes up plant nutrients in comparatively larger quantities during the process of blossoming and setting, swelling and ripening, than what it does during other times. In order to meet this requirement adequately and in time, it would be advisable to apply the fertilizers carrying the plant nutrients well in advance of these periods. Thus with a plentiful supply of the plant nutrients, the plant will be able to meet all the requirements of making new wood and leaf, maintaining them and the old wood and leaf, preparing for the next blossoming and setting processes and also in maintaining and maturing the crop evenly.

Coffee plants are susceptible to disease and insect attack. The most common disease affecting *arabica* coffee is that caused by the rust fungus *Hemileia vastatrix* which attacks the leaf and spreads all over it. The disease spreads from leaf to leaf and causes heavy dropping of leaf. This results in the arrest of photosynthesis and accumulation of carbohydrates, so that the plant has to draw on its reserves for its very existence and thus becomes debilitated. In such a condition, the coffee fruits are not able to mature well and the coffee from it would have very poor quality. Therefore, it is very necessary to spray the coffee plant with Bordeaux mixture which prevents the spread of the disease.

When all the factors mentioned in the preceding paragraphs have been fulfilled, one may expect to have a good quality producing coffee fruit to be grown on the coffee plant. If this fruit is not properly handled, it may lose its quality because of impurities which it can gather during the preparation of the fruit into clean coffee. Two methods of preparing coffee fruit for the market are known : (*i*) the wet or the plantation method, (*ii*) the cherry method. In the plantation method, the ripe cherry is passed through pulpers where the outer skin is removed and only the bean covered by its parchment cover and the mucilage above it passes out. These beans are collected in vats where they are allowed to undergo fermentation in order that the mucilaginous material may be easily washed out. If in this process, the fermentation is allowed to continue too long or if the skins are not properly removed and allowed to ferment along with the wet parchment, the coffee that results would have what is known as a fruity taste. The acquisition of foreign taints and flavour is possible, the longer the wet parchment is allowed to stay in the vat in an unwashed condition. Many attempts have been made to reduce the time of fermentation or the time taken for the freeing of the mucilage from the bean by the use of pectic enzymes and also chemicals. Although success has been achieved in reducing the time taken for freeing of the mucilage from the parchment from the usual 36 hours to 10 minutes by their use, it is yet not certain what the effect of these chemicals or bio-catalysts may have on quality.

Scrupulous cleanliness in the handling of the parchment and thorough washing after the mucilage is freed, go a long way in improving or maintaining the quality of the coffee. After the parchment has been washed, it is also necessary to dry it on tables raised above the ground to prevent contact with earth which may cause what is known as 'earthy taste' in the cup. In the cherry process, the coffee is dried in its skin and then hulled. This gives what is known as a 'fruity cup' and is considered to be an unclean coffee. However, if cherry coffee is allowed to monsoon—keeping the coffee in bags during the monsoon in godowns near the coast and airing and changing the bags every week or fortnight—it would remove the fruity taste and give a good cup although not of the same quality as of the best parchment. After the coffee, whether it be plantation or cherry, is peeled, it is necessary to have it well garbled to remove broken, black, malformed, withered and green beans from the assortment. This will remove any chance of a stinker getting into the good coffee and spoiling the taste.

It is possible even in the best coffee prepared in the best manner to spoil it at the stage of actually roasting and brewing. It is quite a common practice even today to roast the coffee black, so that it sweats oil and then grind it. While this, no doubt, gives a much darker brew, it will not give a good cup. The ideal roasting should be such that the coffee is dark brown in colour and should not sweat oil when kept. It is always advisable to roast the coffee in small quantities, so that it can be used up within a very short time. In a similar manner, it is profitable to grind the roasted coffee fresh and then brew it. If roasted beans or the roasted and ground powder are kept for any length of time, they would produce a stale coffee in which one can detect a rancid taste caused by the oxidation of the coffee fats. In brewing coffee, it is very necessary to have very clean vessels and boil the water fresh. The use of percolators, both metal and glass, would produce good quality coffee. Here again, one has to exercise great care to see that the vessels are perfectly clean and do not carry any remains of the previous brewing. The quantity of coffee powder that goes to produce a cup of coffee also determines the excellence of the coffee brewed. It has been estimated that a pound of coffee powder should provide at the maximum about 40 cups. If this proportion is exceeded by having more water for lesser quantity of powder, one can expect to have a very thin brew which may not be satisfying at all.

GOOD FARMING PRACTICES AS AIDS IN THE CONTROL AND PREVENTION OF INSECT PESTS

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Government Entomologist

Farmers can prevent many crop pests by good farming practices. Among such practices, deep ploughing, rotation of crops, time of sowing and harvesting and clean cultivation are important. They aid in prevention of many crop pests without entailing separate expenditure of money, time and convenience. These methods are particularly applicable to the pests of cereal and fodder crops, because they are grown over lakhs of acres and it is not easy to apply insecticides on them. However, some of these practices are helpful in preventing pests of vegetables, fruit trees, forest plants and some crops.

Agricultural Operations

Early Sowing of Jola in Mysore District to Skip the Outbreak of Earhead Bug and Fly

Jola is grown on about two lakhs of acres in Mysore District. At the time of milk formation in the grains of the earheads, the bug, popularly called *Arukalchitte* and a fly, infect and suck the sap of the grains, turning them chaffy. Every year they break out in July immediately after a few showers. Late sown *jola* will have milk-forming grains at this time and will be susceptible to the attack of the pests. If care is taken by all the farmers to sow *jola* at the end of March or early April, the grains will have past the milky stage in July and escape the infection, because the insects cannot suck the hardened grains. Of course, for such early sowing, early rains, particularly *Revathi* (March 30-April 11) must aid. But in any case all the farmers must make it a point to sow early and simultaneously. If sowing is done at different times, susceptible milky grains will favour the attack and spread of the two pests.

Light Earthing Up will Prevent Sugarcane Seedling Borer

The habit of the seedling borer larvæ is to congregate on the inner surface of the just opening first leaf-sheath at the bottom, and grow for a while feeding upon the tissue. Then they take the horizontal turn and bore into the main stem and produce dead hearts. Light earthing up of the young crop at the first month, to cover the bases by about 4″ of soil all round, will cover the leaf-sheaths and prevent the larvæ from congregating on the inner surface. If they have already got in, they will be smothered by the soil falling on them. All the sugarcane cultivators in Mandya District have taken up light earthing as a routine operation.

Light earthing up of ragi and *jola* seedlings will also prevent the stem-borer larvæ from boring at the bottom.

Bund Scraping Destroys the Grasshopper Egg-Pods

Paddy grasshoppers deposit their eggs 2-4″ below the soil on the bunds during November-December. The eggs remain in the soil till next June-July. After the monsoon showers the eggs hatch and the hoppers come out. If the soil on the bunds is scraped about 4″ deep before the eggs hatch, during April-May, the egg pods are exposed and destroyed by sun and wind.

This practice holds good to the *jola* grasshopper also, a serious pest of *jola* in Chitaldrug District.

Destruction of Stubbles after Harvest to kill the Lurking Insects

After paddy is harvested, the stubbles must be ploughed up, gathered together and burnt up. This is very necessary and a useful aid to kill all the lurking stages of paddy stem-borer in the stubbles. Otherwise, the pest continues to develop and multiply and spread to the next crop.

If tobacco stubbles are removed and burnt up, after the crop is harvested, the larvæ and pupæ found in the stems, can be destroyed.

To prevent the spread of cotton stem weevil, it is very necessary to remove the stubbles after harvest and burn them.

Early Threshing will kill Earhead Webbing Caterpillar

Earhead webbing caterpillar is a serious pest on *jola* and ragi. The caterpillars cut the hardened grains and feed on them. They multiply on the earheads in the stacks and destroy the entire crop before it is threshed. If the infection is seen on the standing crop, it is best to thresh the harvested earheads very early so that the caterpillars and pupæ get crushed.

Proper Shade-Regulation to prevent Coffee Stem-Borer; and Destruction of Borer-Attacked Plants to Prevent Further Spread of the Pest

The coffee stem-borer attack has been found to be severe in the plants exposed to sun as the beetles prefer the exposed plants more than those in the shade. So it is better to regulate and maintain proper shade to all the plants so that the borer attack is minimised. If the plants have been attacked already, it is very necessary to root out all such plants and burn them before the close of September; otherwise the beetles begin to come out of the stems and oviposit on other healthy plants.

Destruction of Ant Nests to Prevent Spread of Green Bugs

Ants have been found to attend on green bugs for the sake of the honeydew—the sweet excreta on which they feed. For the sake of honeydew, they carry the green bugs from place to place and thus spread the pest. The same kind of association is also found between ants and aphids which are serious pests on many economic plants. To prevent the spread of green bugs in coffee estates, and aphids in other places, the ant nests must be traced and destroyed, before the control of green bugs and aphids is taken up.

FIELD SANITATION

Destruction of Pupæ of Cardamom Hairy Caterpillar

The cardamom hairy caterpillar is a serious pest in the plantations during winter months. They pupate among dried leaves and debris at the base of cardamom plants and shade trees. They can be easily recognised. It is very necessary to sweep them together and burn them, to prevent the multiplication of the pest.

Removal of Plant Refuse in Plantain Gardens

The plantain weevil is a serious pest of rhizomes. The adult weevils take shelter in the cut stems and other debris left near the plants. They spread to the plantain trees and infect them. So all plant parts must be removed and burried, to keep the place clean.

Removal of Alternate Weed Host Plants of Epilachna

Epilachna is a serious pest of potato. It infects other plants like brinjal, gourds, cucumbers and *kachi*, a weed plant. It is better not to grow the alternate host plants near potato plots ; and it is very necessary to remove the weed host plants and keep the surroundings clean ; otherwise the pest multiplies on the weed plants and spreads on to the economic plants.

ROTATION OF CROPS

Rotation of crops is a good aid to prevent a specific pest on a particular crop. To illustrate, the paddy stem-borer is a specific pest on paddy (it is rarely seen in some grasses). If, in a particular region, where the borer havoc is severe, all the paddy cultivators were to stop growing paddy and grow some other crop, say, sugarcane or ragi, the paddy stem-borer dies from starvation, as it cannot get its specific host. A specific pest can be controlled by this practice ; but all the farmers must be united in their efforts, otherwise it serves no purpose.

GROWING RESISTENT VARIETIES

By growing varieties which are resistent to particular pests insect pests and plant diseases can be prevented. Of course, it takes a long time, sustained research with money and energy to evolve such resistent varieties. But instances are not lacking. In Western countries, Hessian fly has been prevented by evolving resistent varieties of wheat.

CONCLUSION

The competition between man and insects has been relentless. Every good farming practice to grow better crops—good seed-beds, sowing better seeds, proper manuring, and irrigation and planting resistent varieties, etc., will prevent serious insect pests permanently without involving extra expenditure. The farmers must adjust such cultural practices according to circumstances and prevent insect pests.

INSECT PESTS OF VEGETABLES AND THEIR CONTROL

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Civilisation is said to have begun with the cultivation of the soil. Ever since man began to till the land, vegetables are being raised. It is almost instinctive on the part of man to grow at least a few vegetables, be it in his farm or backyard. Vegetable-growing is a delightful hobby and, at the same time, it provides him with his daily needs of vegetables ; and if he should grow more of them he can even make a good income out of it. Vegetables are an important adjunct to man's food ; and they are a necessity for his balanced diet. They provide him with all the vitamin and mineral requirements. The leafy vegetables are particularly prescribed even by doctors under certain conditions like constipation, skin troubles, etc.

There is real pleasure in eating vegetables raised by one himself. However fresh the vegetables purchased in the market are, they cannot be compared with those that one raises and picks up for cooking. He seems to enjoy what he has grown much better than those purchased.

It is the desire of every vegetable grower to grow better vegetables. It is with this desire that he digs the soil, manures it, puts in good seeds and waters them. But these measures are not enough to get good vegetables unless he protects them against insect pests. It may be the common belief that luxuriantly grown vegetable plants will resist the insect attack. But it must be remembered that luxuriantly grown vegetables will attract the insect pests more than others; and the insects thus attracted will damage the plants and nullify the objects of the grower. So he must take all precautions to protect the vegetable plants (as in the case of other plants) from the ravages of insect pests. Insect pests damage the plants in several ways : by chewing the plant parts ; by sucking the sap ; by boring into the roots, stems, leaves and fruits ; and in many other ways.

Let us consider some of the major insect pests of vegetables that are commonly grown.

Cabbage, Cauliflower, Knolkhol, Turnip, Etc.

Please take a look at the chart (photo). On the upper left are shown some of the cruciferous vegetables like the cabbage, knolkhol, radish, cauliflower, turnip ; to these may be added the mustard. The major insect pests common to these crops are *Prodenia littura* F., *Crocidolomia binotalis* Zeller., *Plutella maculipennis* Curt., sawfly, aphids and the stink bugs. Of these, the first four are chewing insects which bite the plant parts and bore into them ; the latter two are sap-sucking insects.

Let us know a little about each of these pests regarding their habits, nature of damage and how we can control them.

Prodenia littura F.

This is called tobacco worm as it attacks tobacco also. In addition, it attacks castor, banana, tomato, *agathi*[1] and several other plants. It commonly occurs on all the cruciferous vegetables. The host range is so vast that it is a polyphagous creature. The adult is a fair-sized moth and is easily recognised by the pattern of zigzag lines and bands on the upper wings. It is active after dusk and lays eggs on the leaves in masses and covers them up with buff-coloured hairs derived from the tip of the abdomen. It is easy to recognise the egg masses. The eggs hatch in about 4 days and the tiny caterpillars feed gregariously, skeletonising the leaves, which can be recognised from a distance. As they grow in size they begin to scatter. In about two weeks they become stout, dark caterpillars with bands and dark spots on the body. They behave like cutworms hiding under clods and soil during the day, and feeding on the plants after dusk. After full growth they pupate in the soil. In another two weeks the adult moths emerge from the pupæ. The life-history occupies about 30-40 days.

It is the caterpillar which feeds voraciously and it is omnivorous in habit. If ignored, the caterpillars defoliate the whole plant quickly.

Control.—Egg-masses can be easily picked up and destroyed. Advantage must be taken of the gregarious habit of young caterpillars. The skeletonised leaves can be made out from a distance, and such leaves together with hundreds of caterpillars can be pinched and destroyed by dropping them into kerosened water. After they grow in size and hide below the clods and soil it becomes difficult to control them. The soil can be flooded, or dug up to expose the lurking caterpillars and pupæ which can be collected and destroyed. If the area is large, stomach poisons will have to be sprayed on the leaves for the caterpillars to eat and die. But as they are vegetable plants one must be very careful in using stomach poisons. 50% DDT or BHC wettable powder, 1 lb. in 16 gallons of water can be sprayed on the leaves if plants like cabbage are not in heads. In any case vegetables will have to be washed thoroughly before use or marketing.

Crocidolomia binotalis Zeller.

The adult is a small moth having pale brown mottled upper wings with characteristic wavy bands. Eggs are laid singly on the plants and the green caterpillars with stripes on the body, bite the leaves and burrow into the cabbage heads and even stems. Pupation is in the soil.

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[1] *Sesbania grandiflora* Pers.

Plutella maculipennis Curt.

The parent moth is very small, brown in colour with characteristic marks on the wings which appear, when the moth rests, like a diamond. Hence it is called diamond-back moth. It lays eggs singly on the leaves and the caterpillars are small, green and spring when disturbed. They pupate in a silken web on the leaves.

Control.—The caterpillars of these two moths are very common on cabbage and are quite serious pests. To control, the plants may be dusted with 5% BHC powder. Vegetables will have to be washed thoroughly before use.

SAW FLY. *Athalia proxima* Klug.

The parent insect is a wasp which resembles a bee. Eggs are thrust into the tissue of the plants and the young ones hatching from the eggs resemble caterpillars. They commonly attack radish, cabbage, and most other cruciferous plants and bite holes on their leaves. They are greyish dark in colour. They pupate in the soil.

Control.—If the attack is noticed very early the caterpillars can be handpicked and destroyed. Later the attack may be controlled by dusting 5% BHC, or spraying 50% DDT or BHC wettable powder 1 lb. in 16 gallons of water.

SUCKING INSECTS. APHIDS. *Myzus persicœ* Sulz.

Most common on cabbage, radish, etc. Thick infection is seen on the lower leaves on the plants. They suck the sap of growing plants which become stunted in growth and finally the plants are killed. Thousands of these small green plant lice are seen on the leaves, as the females reproduce even in the absence of males.

Control.—Remove all old badly infected and sand leaves, collect them together and bury them. Then the plants may be given a drenching spray with fish oil or *honge* oil resin soap, 1 lb. in 16 gallons of water. Repeated sprays are necessary as some aphids escape and rebuild quickly.

STINK BUGS. *Bagrada picta* Fb.

It is a dark brown bug with reddish brown markings. Eggs are laid on the plants. Both nymphs and adult bugs suck the sap of the plants and make them stunted. They emit a bad odour and hence are called stink bugs.

Control.—Dusting of 5% BHC powder.

BRINJAL, POTATO, SWEET POTATO

The next common vegetables grown in the backyards and in gardens are brinjal, potato, sweet potatoes, etc., shown at the left bottom of the chart. Some very serious pests are met with on these plants.

Epilachna viginti-octo-punctata F.

This is a very serious and common pest on potato, brinjal, melon, gourds, cucumbers, *kachi*, etc., plants. The beetle is popularly called ladybird beetle, because of its pattern of several dark spots on brown elytra. It occurs in all places. Yellowish eggs are laid in clusters on the leaves. The grubs are yellowish, spiny and become stout as they grow. The grubs as well as beetles eat the epidermal layer of leaves in a characteristic ring-like fashion. The nature of damage can be easily attributed to the *Epilachna* pest. They pupate on the plants.

Control.—In the beginning, if the insects are a few, systematic handpicking will help in reducing the pest.

Spraying of calcium arsenate mixture has been very effective and popular among potato cultivators. If the pest is on brinjal it should not be sprayed on the fruits.

Formula

Calcium arsenate or lead arsenate ..	1 lb.	Jaggery ..	3 lb.
Lime ..	2 lb.	Water ..	50 gl.

Preparation.—The lime is dissolved in a small quantity of water and strained. Calcium arsenate is added to the lime water. Jaggery is dissolved separately in a small quantity of water and strained. It is slowly added to lime and calcium arsenate mixture and stirred ; the rest of 50 gallons of water is added slowly and the mixture stirred. It is better to prepare the mixture in small quantities and use it up instead of preserving.

Warning.—Since calcium or lead arsenate is a deadly poison care must be taken not to allow other animals to graze on sprayed plants. The vessels must be thoroughly cleaned. Workers must wash their hands well. While working they should not smoke or chew betel leaves.

The modern insecticides like 50% DDT wettable powder 1 lb. in 16 gallons of water ; Folidol E-605, 0·06% have also been found to be effective on this pest.

BRINJAL STEM-BORER. *Euzophera perticella* Rag.

The borer is a caterpillar, about 20 mm. long, smooth and yellowish white with an orange-brown head. It bores into the stems ; and also pupates within the stem burrow. Its adult is a small moth pinkish brown in colour and is active after dusk. This borer attacks brinjal, chillies, potato, etc.

BRINJAL FRUIT AND STEM-BORER. *Leucinodes orbonalis* Gn.

This borer is pinkish with dark smooth warts emitting short bristly hairs. It bores into both fruits and young shoots. Some times it is a serious pest. Pupation is inside the fruit or stem. The moth is small, pale white with reddish patches on the upper wings.

Control.—Both the borers are difficult to control (as is the case with any borers) when once they are inside the plant parts. Attacked plants have to be destroyed to prevent further spread. "Prevention is better than cure." The plants must be frequently dusted with 5% BHC; or 1·5% Folidol dust, to prevent the moths from egg-laying.

SWEET POTATO WEEVIL. *Cylas formicarius* Fab.

This is a very destructive pest of sweet potato. The adult resembles an ant with a long snout and dark blue colour on the abdomen and head, the thorax being brown.

Small oval eggs are laid on the stems and tubers. The grubs mine into the stems and also into the tubers. They even multiply in the stored sweet potatoes. Pupation is inside the tubers or stems. It is a difficult pest to control. Badly attacked plants will have to be burnt up. For prevention, Folidol E-605, 1·5% may be dusted.

STORED POTATO TUBERWORM. *Phthorimœa operculella* Z.

It is a serious pest of stored potato. In the field it attacks potato and tobacco also. The moth is small, pale brown in colour, and lays eggs on the plant and stored tubers in the depressions and eyespots. The caterpillars, if in the field plants, mine into the leaves. On the stored tubers they tunnel into them and damage them. After fully grown they come out and pupate outside among inert materials.

Control.—Sweet potatoes must be stored under dry sand and examined twice a month.

Cover the tubers with a loose sheet of gunny and dust on the gunny with 2% Hortex or Lindane. The gunny may also be sprayed with 50% DDT wettable powder, 1 lb. in 16 gallons of water. This treatment is to prevent the moths from egg-laying.

GOURDS

We will now take up the gourds like the pumpkin, snakegourd, bittergourd, etc., shown on the upper right of the chart.

THE PUMPKIN BEETLE. *Aulacophora abdominalis* Fab.

This is a serious pest of cucurbitaceous plants like pumpkin, snakegourd, bittergourd, cucumber, melon and has been found on potato also. The beetle is medium-sized, with red elytra. Different species with blue and grey elytra also occur. They bite holes on the leaves and appear in large numbers on the above plants. The grubs are found in the soil and damage the roots of the host plants.

Control.—A stomach poison spray with calcium arsenate mixture as in the case of *Epilachna* pest will control this pest. A 5% BHC dust in the early mornings on both sides of the leaves will deter the beetles.

Soil treatment incorporating 5% BHC around the roots of the plants will kill the grubs.

Epilachna viginti-octo-punctata F.—This pest occurs also on cucurbitaceous plants. It has been dealt with under potato and brinjal.

FRUITFLY. *Chœtodacus cucurbitœ* C.

Several species of fruitflies occur on young fruits of cucurbitaceous plants and also on ripening mango, guava, orange, peaches, etc. The fruitflies can be easily distinguished from their triangular abdomen with beautiful shining spotted wings unlike those of house flies. They thrust their white cigar-shaped eggs into the tender pumpkin or gourd fruits. The maggots feed on the pulp of the fruits which very soon drop down. The maggots unlike those of ordinary flies, jump into the air when disturbed. The grown up maggots get into the soil and pupate.

The fruitflies are a serious pest. The life-history is practically the same in different species that occur on vegetable plants or on other fruits.

Control.—All attacked and fallen fruits must be collected and burnt. They should not be thrown about as the maggots get into the soil and pupate.

The soil around the plants and fruit trees must be ploughed up to expose the pupæ which get destroyed by sun and rain.

The adult flies must be attracted to poisoned syrup. The flies feed on the syrup and die. The syrup is prepared by mixing 2 oz. of sodium silicofluoride with 2 lb. of sugar and dissolved in 4 gallons of water. This may be sprinkled on the foliage and exposed in small tins near the plants or hung on fruit trees.

ONION, CHILLIES, BEANS, OKRA (*Bhende*)

On the right side bottom of the chart are shown other vegetables like onion, hillies, beans and *Hibiscus esculentus* (*Bhende*).

THRIPS ON ONION. *Thrips tabaci* L.

THRIPS ON CHILLIES. *Scirtothrips dorsalis* H.

These are very small insects with fringed wings. Large number of them is seen on the foliage, particularly tender parts, sheaths, etc. They lacerate the tissue and suck the sap. In the case of onion, the leaves get blighted and dry up as though for want of water. They attack garlics also. In the case of chillies the tender leaves get curled up, the thrips being found in the rolled margins. Finally the plants wither and dry up.

Several species of thrips occur on other plants and they are a serious pest.

Control.—They can be easily controlled by spraying fish oil or *Honge* oil resin soap, 1 lb. in 6 gallons of water at frequent intervals.

A spray with Folidol E-605, 0·02% has been found to be very effective on this pest.

JASSIDS ON *Bhende*. *Empoasca devastens* D.

These are small greenhoppers found in thousands on the leaves. They suck up the sap from the leaves, which results in general weakness of the plants, and in case of bad attack, leaf curling and withering. The leaves turn yellow and become mottled. These insects are said to be the vectors of a virus disease also.

These are a serious pest on other plants like brinjal, cucurbits, sunflower, cotton, castor, tea and several others. They can be easily recognised by the presence of two black round spots at the posterior third on the wings in the case of adults, and on the anterior part of wing pads in nymphs.

Control.—They can be easily controlled by spraying 50% DDT wettable powder, 1 lb. in 16 gallons of water.

BLISTER BEETLE ON BEANS. *Mylabris pustulata* Thnb.

This orange-banded blister beetle is almost a polyphagous insect and is of common occurrence. They feed on flowers, pollen and tender shoots of many plants, *e.g.*, beans, sweet potato, cowpea, *lablab*, cucurbits, groundnut, redgram, cotton, *pundi*[1] wild ipomœas, prickly pear, *Hibiscus* spp., rose, sometimes on earheads of *sajje*,[2] *jola*, etc. The eggs are laid in masses in the soil and the grubs are beneficial creatures as they eat grasshopper eggpods and do not damage any plant parts.

Control.—The adults are the worst enemies of cultivators and can be collected by hand nets and destroyed. A dust with 5% BHC on the flower parts will deter the beetles.

TOMATOES, PEAS

In the centre of the chart are shown two more commonly grown vegetables, tomatoes and peas.

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[1] *Hibiscus cannabinus* L.

[2] *Pennisetum typhoides* Stapf.

TOMATO FRUIT-BORER. *Heliothis obsoleta* Fab.

This is a polyphagous insect. The moth is fairly big and has dusky brown upper wings with a round pale spot in the centre. Eggs are laid scattered on the plant parts. The caterpillars are voracious feeders ; they eat all parts of plants and even bore into the fruits. They are green with stripes and short hairs on the body. But several colour phases like the yellow, pink, dark, etc., are commonly seen. Pupation is in the soil. The caterpillar, when it bores into the tomato fruit, thrusts its head into the fruit with the body outside. They attack many different kinds of plants, *e.g.*, tomato, tobacco, corn, cotton, bengalgram, redgram; groundnut, *ganja*,[3] cabbage, safflower, linseed and many other low-growing plants.

Control.—A careful watch must be kept up and if the plants are a few, caterpillars can be handpicked and put into kerosened water. If the fruits are young, 50% DDT wettable powder 1 lb. in 16 gallons of water may be sprayed. The fruits must be washed before use.

PEA APHIDS. *Macrosiphum pisi* Kalt.

These are very hardy plant lice, thickly infesting the tender parts of the plants. They are very common and since they suck the sap from the tender parts, the plants are completely killed. A potent contact poison spray is necessary.

Spraying with Folidol E-605, 0·02% has been found to be very effective against this pest. Folidol dust 1·5% can also be dusted on the plants.

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[3] *Cannabis sativa* L.

HOUSEHOLD INSECTS AND THEIR CONTROL

BY DR. M. PUTTARUDRIAH, B.SC. (HONS.), PH.D. (CALIF.)

Government Entomologist

MANY kinds of pests invade households and cause troubles in numerous ways. Termites, carpenter ants and wood-borers destroy buildings and furniture. Clothes moths, carpet beetles, silver fish among books and photoframes, cockroaches and crickets damage clothes and carpets. Weevils and beetles, moths, mites, flies, cockroaches and ants infest food. Flies, mosquitoes, fleas, lice, mites and cockroaches spread diseases. Scorpions, wasps and ants sting us. Bed bugs, lice, fleas, mites, mosquitoes, ticks and some spiders suck the blood of men and cattle. Eyeflies annoy us during certain months in the year. Many other insects invade houses and prove a nuisance though they do not cause any particular damage. Such, are spiders, millipedes, centipedes and some ants.

Bed bugs, silver fish, clothes moths, cockroaches and ants spend their entire lives in houses and other buildings. Others live outside but invade into households in search of food. Still others, under favourable conditions, invade houses in large numbers. Scorpions, centipedes, earwigs and beetles get into houses sometimes and frighten us. Many moths, flies, termites, crickets, winged ants, some grasshoppers and plant mosquitoes get into houses in myriads, being attracted to light.

Household insects are troublesome not only in houses, but also in hotels, storehouses, offices and factories. They annoy the workers, destroy records, contaminate food, and damage raw materials and finished products.

India being a tropical country, is favourable for millions of insects. As the population and cities increase and as the hotels and factories multiply, food becomes more and more available and the household insect problem becomes acute.

Control of household insects is not very easy. They cannot be controlled by the use of any one insecticide once in all places. For effective control, some fundamental practices must be followed.

Thorough sanitation and good housekeeping are of paramount importance in the control and prevention of many household pests. Such practices will prevent many insects from invading into houses. Removal of garbage, bits of food and rag, etc., will reduce the chances of availability of food and shelter to many insects. Otherwise, if they are left in corners, insects take shelter and multiply.

Just as the doctor diagnoses a disease before prescribing the treatment, so is it necessary to identify every insect before taking up control measures. Different insecticides may be necessary for different insects.

CONTROL MEASURES AGAINST SOME HOUSEHOLD INSECTS

Cockroach.—There are three types. The American cockroach is big and winged. The oriental cockroach is big but wingless. Both are dark brown, and live in warm, cool places. They congregate in kitchen, fuel storage places, food stores and sewage manholes. The german cockroach is small, winged and very active. They can be found in all sorts of places in the house. Hundreds of them may be found in kitchen, bathroom, suitcases, almirah, cupboards, tables and other covered places.

Cockroaches are difficult to control. A potent insecticide must be dusted or sprayed to go in contact with them. They drop down and get paralysed. Pyrethrum powder can be dusted on them when they are found on the walls and in the cupboard, care being taken to protect the food products. If lights are switched off for a while in the night, the cockroaches congregate on the walls. Lights can be put on, and the pyrethrum powder immediately dusted or sprayed on them. It is better to use a duster or Flit pump for this purpose. "Fip" an insecticide containing pyrethrum is sold in the markets.

Two per cent. chlordane is also an effective spray on the cockroaches. PDB[1] crystals can be placed in suitcases, wardrobes, to ward off cockroaches. As the crystals evaporate they must be replaced. It is a good deterrent against many other insects.

Bits of foods, fruits and grains should not be made available to the cockroaches particularly in kitchens and worship rooms. Cockroaches must be killed as and when they are seen. Cats hunt and eat them.

Many kinds of insects invade into the stores and cupboards for food ; these places must be kept absolutely clean. Frequent dusting with 5% DDT on the floor will deter these insects.

Silver Fish.—These are small, greyish white, fish-like insects always found behind photoframes, corners of doors and windows, and bookcases. They scuttle away immediately when exposed. They feed upon the starch found in bookbinds and papers ; sometimes they are destructive to rayon articles.

Thorough dusting of 10% DDT or spraying with 5% DDT in the cracks and places where the silver fish live will be effective against these insects.

Ants.—Ants are of several kinds—red ants, black ants, *Camponotus*, the big black ants and the stinging ants, etc. During rainy season winged ants are attracted to light in the house and become a nuisance.

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[1] Para dichloro benzene.

For any kind of ant trouble, the nest must be explored and destroyed by dusting 5% chlordane powder or spraying 2% chlordane liquid around the nest.

Clothes Moths.—To destroy the clothes moths, it is better to spray the closet walls and shelves once or twice a year with 5% DDT. Crystals of PDB can be kept in the folds of clothes.

Blankets, rugs and carpets can be protected from the ravages of carpet beetles, by treating them with 2% chlordane. The floor may be similarly treated where the carpets and blankets are spread.

House Spiders.—Though they do not cause any particular damage, they annoy us by webbing at the corners and under furniture. It is best to clean such places frequently by removing the webs and killing the spiders. If necessary, 2% chlordane may be sprayed in such places where the spiders are likely to get in.

House Crickets.—These insects can be easily controlled by dusting 10% DDT in the corners where they hide.

Bedbugs.—Bedbugs can be readily controlled by spraying 5% DDT on the walls, taking care to block all the holes and crevices. DDT can be mixed with lime water and used for whitewashing the walls. Five per cent. BHC powder can be spread in a line all around 2" from the wall. Bed bugs which descend from the walls during nights are caught in the powder and will be killed. In the mornings, the powder may be gathered together for use again in the night. The BHC powder once spread may serve for use during three nights and then it is discarded.

Wasps.—House wasps and yellow jackets build mud nests in the corners behind doors and windows and annoy us. They can be destroyed by putting a little DDT powder into such nests.

White Ants.—If neglected even for a short while, termites will destroy all things. They tunnel underground and the walls and attack the beams, furniture and books. It is necessary to find out the brood nest and destroy the queen ant, for successful control of white ants. A spray with 50% BHC wettable powder, 1 lb. in 16 gallons of water will effectively control the white ant attack. The winged termites are attracted to lights in large numbers during rainy season. The termite nests found in the neighbourhood of houses must be dug out and the brood with the queen ant must be destroyed. The winged ones can be collected in a pan of kerosened water held under the light to which they are attracted.

Eye Flies.—Eye fly annoyance starts from June-July and continues till September. They are a nuisance in the afternoons, and they are not found in cooler hours. Long threads may be hung up from the ceilings, for the eye flies to collect in large numbers. Pyrethrum extract sprayed by a Flit up on the hanging threads will kill them. This treatment may be repeated often.

CONTROL OF RODENTS IN FIELDS AND GRANARIES

By D. SESHAGIRI RAO, B.Sc.

Joint Entomologist, Mysore State Department of Agriculture

RODENTS (rats, mice and bandicoots) are perhaps the worst mammalian enemies of man, causing enormous losses to stored produce of various kinds, damaging structures, and spreading disease. Since the dawn of history, several species of the rat tribe are living in 'intimate' association (known as *commensalism*) with, and at the expense of mankind, all the world over. This long relationship with its human host, has given the rat a certain superiority in this perpetual game of 'hide-and-seek' and has resulted in its developing an uncanny agility and sensitiveness to 'atmosphere', unlike the domesticated animals which have become, by contrast, heavy-footed, tame and somewhat 'foolish'. In its constant struggle for existence as the unwanted guest of man, the rat has become a nocturnal and 'underground' worker which makes it certainly more difficult for man to effectively check its depredatory and destructive activities.

No reliable estimates of the toll taken by rats are available, but the tentative estimates attempted by competent authorities give a clue to the colossal strain that these unwelcome intruders are imposing on man's economy. Coyne (1945) estimated that one million tons of foodgrains are annually lost on this account in India. Kalmbach (1948) has conservatively estimated that 200,000,000 dollars worth of food and other materials are lost to the rodents every year in U.S.A. It must be remembered that rats damage and spoil much more than what they actually consume by fouling foodstuffs with their droppings, and by spilling them about.

The conventional methods of control of these pernicious pests are : (1) rat-proofing, (2) trapping, (3) gassing, and (4) baiting. These lines of control are briefly described below :

(1) *Rat-proofing.*—Structural modifications or improvements which will effectively keep out rats are included here. The provision of a 9″ wide ledge all along the outer wall, below the window-sill, prevents rats climbing up the wall. A favourite place through which a rat gains entry inside is by gnawing a hole at the bottom where the two door-shutters meet ; nailing a narrow strip of tin in such a way that the bottom half of the strip hangs loose and can be tucked under the door when it is shut, prevents this. Other precautions that may be instanced are, cutting off the branches of trees, if any, overhanging the building, keeping window panes in good repair, blocking up the space between wall and roof (if

it is a tiled roof), etc. Rats are generally accustomed to follow definite paths or rat-runs ; in one instance, it is reported that the rat-nuisance in a silk factory was traced to a broken pane on one of the windows, and a convenient box left obligingly beneath it. When the window pane was replaced the visits ceased.

(2) *Trapping.*—Mechanical contrivances of different kinds into which rats are lured by attractive food are in use. A small box with wire mesh or wooden sides and a spring door and the break-back treadle trap are familiar examples. A box trap with a tilting lid which is useful to control the infestation inside a godown is described in the *Mysore Agricultural Calendar* for 1949-50 (see sketch).

The useful role filled by cats may be included here. They may be depended upon to exert a moral influence on a mild infestation within the premises, but are helpless if there is a heavy population of rats. Dogs are sometimes trained to hunt bandicoots.

(3) *Gassing.*—This is a safe and sure method for controlling infestations in premises and fields where extensive burrowing is seen. Two principal preparations, 'Cymag' and 'Cyanogas' which evolve hydrocyanic acid gas on exposure to air are commonly employed. 'Cymag' is useful under field conditions, where the mouths of burrows are carefully located, and a spoonful of 'Cymag' is dropped deep within the burrow with a long-handled spoon and the opening sealed with wet earth. 'Cyanogas' which is extensively used for rat-control work by the Public Health authorities is pumped into the burrows with a foot pump duster.

(4) *Baiting.*—In baiting, a suitable poison camouflaged in an attractive food material (called the base) is kept exposed in the path of the rats. This involves a careful technique and is considered the best method yet devised for the destruction of rats. By adopting recent improvements it is possible to secure 80-100% kill of the rats in the area. Rats being highly suspicious by nature, it is necessary to induce them to accept the bait by first offering unpoisoned food (pre-baiting) and subsequently the poisoned bait. A successful period of bait-laying may sometimes suddenly end, though the infestation is still present, thereby showing that the rats have become suspicious of the bait and are avoiding it. In such cases, pre-baiting has to be started again, followed by baiting with a different poison (follow-up treatment).

The bait bases (food media) generally recommended are :—grains, *atta,* gramflour, and rice-bran or wheat-bran for 'dry' baits ; for moist baits, stale bread soaked in water, soaked wheat, crushed and soaked barley or maize, boiled rice and damp sausage rusk (resembling biscuit powder). Poisons in common use are listed below :

1. Zinc phosphide—5% by weight.
2. Arsenic—10% by weight on wet baits and 15% on 'dry' baits.

3. Barium carbonate—20% by weight on 'wet' baits.

While working in the Food Department, the writer had occasion to test the following proprietary products :

Product	Composition	Proportion in baits recommended	Results
1 Zelio grains	Wheat grains dipped in Thallium compound	..	Effective against mice in dwelling houses, offices, etc., where they are a minor nuisance
2 Zelio paste	Thallium compound	1 : 10	Useful against rats in stores, godowns, etc.
3 Castrix poison grains	Pyrimidine compound	..	Useful for control of field rats
4 Muritanyl	Alpha-naphthyl-thiourea	1 : 100	Effective against rats in godowns and stores
5 Warfarin	Coumarin derivative	1 : 20	do
6 Tomorin	do	..	do

While these proprietary preparations are effective raticides, care has to be taken to see that they are not carelessly left about within reach of children and pet animals or that foodstuffs get contaminated with them.

Indigenous methods of baiting without employing chemical poison such as the use of cooked rice mixed with glass pieces against bandicoots, and bits of pith dipped in syrup with a pan of water kept conveniently near, against house rats and mice may also be mentioned.

In conclusion, the problem of rat control in granary and field is one beset with serious difficulties, and calls for sustained and patient effort. The methods outlined above are intended only for general guidance ; the measure of success achieved depends upon the care with which the campaign is planned and carried out. Sometimes the fall in the incidence of rats in the initial stages of the campaign may appear to be discouraging, often due to some flaw in the method employed or to an inadequate appreciation of the habits of the pest. Such initial failure should not daunt us, but should serve to spur us to greater energy in the task of ridding our premises free of these noxious pests.

COMMON IMPURITIES FOUND IN FOODGRAINS

By D. SESHAGIRI RAO, B.Sc.

Joint Entomologist, Mysore State Department of Agriculture

FOODGRAIN stocks, whether imported or Indian, are never entirely free from foreign matter, technically known as 'refraction' items. Such impurities may be roughly grouped into the following categories :

NATURE OF IMPURITIES

(1) Chaff, husk, straw, calyx-cups, bits of stalks, brokens, fragments, etc. These items come in due to defective cleaning at harvest or the processing stage.

(2) Seeds of weeds, seeds of other crops such as pulses, peas, grams, etc. These are brought in during harvest.

(3) Bored and holed grains, dust and powder, dead and live insects and their fragments, bits of insect webbings and cases, insect and rat droppings. These are due to insect and rat infestation in storage.

(4) Small stones, lumps of earth, etc., mixed with the grain in the threshing or the measuring and bagging yard.

(5) Moist, discoloured or heated grain, often formed into small lumps or masses and emitting a slight smell. This is due to slight wetting in transport or storage, or to fungal or bacterial attack in storage.

(6) Other extraneous impurities like bits of metal, gunny thread, bits of paper, *bidi* pieces, leaves, etc., which come in on account of mixing the sweepings in the grain at the measuring or the drying yards.

These refraction items, while affecting the acceptability of the grain for consumption, also cause a certain amount of direct damage. Thus certain weed seeds like Datura and fungi seeds, ergot and smut are stated to bring about slight symptoms of food-poisoning, while stones, metal pieces and similar impurities cause damage to milling machinery. Further, the consumer who naturally expects to receive his money's worth of clean, wholesome food is disappointed, and is put to extra labour in removing these impurities.

The proportion and nature of foreign matter in foodgrains naturally depends on whether the consignment is from a foreign country, from some other part of India, or from within the State and so on. The categories of impurities found also depends to some extent on the country or place of origin. Grains are harvested and processed by machinery in western countries and since machines cannot discriminate between grains and foreign matter, imported grain usually contains weed-seeds, unripe and shrivelled grains, stalk-bits, chaff, etc. It is generally free from pebbles, lumps of earth and similar impurities. On the other hand, grains from Indian sources contain the latter type of impurities due to threshing and drying being done on *katcha* yards, generally in the open. But defective seeds and weed seeds are usually absent as harvesting is done by hand, and the processing is subject to careful inspection.

Weed-seeds generally encountered in foreign consignments are of wild radish, wild mustard, Mexican poppy (*Argemone mexicana*), buckwheat and wild *amaranth*. Other kinds which have been reported are corn cokle, melilot, vetches, darnel, corn crowfoot and cow-wheat. These species are presumably common weeds in and near fields and their seeds are brought in along with harvested grain.

CLEANING AND RECONDITIONING

Cleaning can be obviously resorted to only in the issue stage by the wholesale merchant, or the retailer, or by the consumer after purchase. In the earlier stages of handling, practical difficulties come in and so 'recoveries' at mutually agreed rates, are claimed by the purchaser. This does not of course apply to existing insect infestation, which can be controlled at all stages.

For large-scale cleaning, *i.e.*, removal of objectionable matter, useful and simple machines are available, of which one or two types are mentioned below :

1. *Hopper Gravity Separator.*—It has a series of graded sieves, one below the other, a hopper on top to feed grain and a dust-collecting chamber and is mounted on four legs. It is hand-operated and can easily deal with about 40 bags an hour. There is a fine model designed by Sri. R. K. Sharma, and another by Kirloskar's which are useful for large-scale cleaning operations.

2. *Winnowing Machine.*—This is equipped with a fan arrangement by which air is blown through a stream of dropping grain. Lighter particles such as dead insects, bored grains, husk, chaff and dust are blown off from sound grain, which can then be passed through sieves fitted below. Fifty to eighty bags can be easily handled in a working day of 8 hours.

There are also other machines worked by power in which the grain is raised to a higher level in which process it is subjected to 'blowing' when the lighter impurities are all blown off. The grain then drops on to moving sieves, where it is further cleaned and graded.

In case of heavy weevilling of grains and consequent accumulation of dust and powder, it is usual to pass it through the 'blower' of a rice mill or flour mill when all lighter admixture including insects will get blown off.

In household cleaning, ordinary bamboo or metal winnows and graded sieves are employed. Winnowing from a certain height in the direction of the wind is a familiar device to separate lighter impurities from the denser, sound grain.

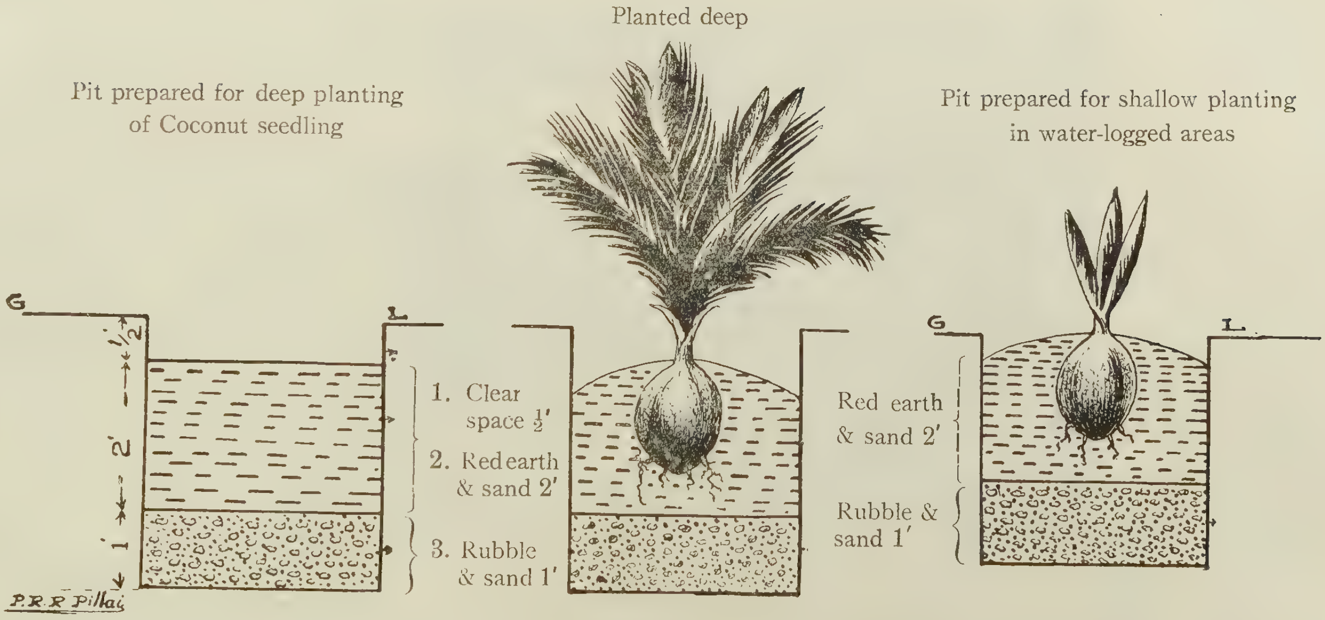
Reconditioning is the process whereby grain affected by moisture, or by a slight attack of fungi or bacteria is rendered attractive and wholesome. Aeration by spreading in thin layers in the sun or shade (for rice) will generally remove the moisture, provided that the grain has not absorbed excess of it, and become in consequence soft and mouldy. Discoloured rice can be reconditioned by giving it a slight polish. Heated grain, which has become soft and mouldy is unfit for consumption, and must be destroyed or dumped into the manure heap.

SHRI JAVARE GOWDA

Shri Javare Gowda of Rudrapatna, Ramanathpur Hobli, Arakalgud Taluk, produced 11,140 lb. (55½ *pallas*) of paddy per acre and won the State Prize of Rs. 1,000 in the Crop Competition held in 1953.

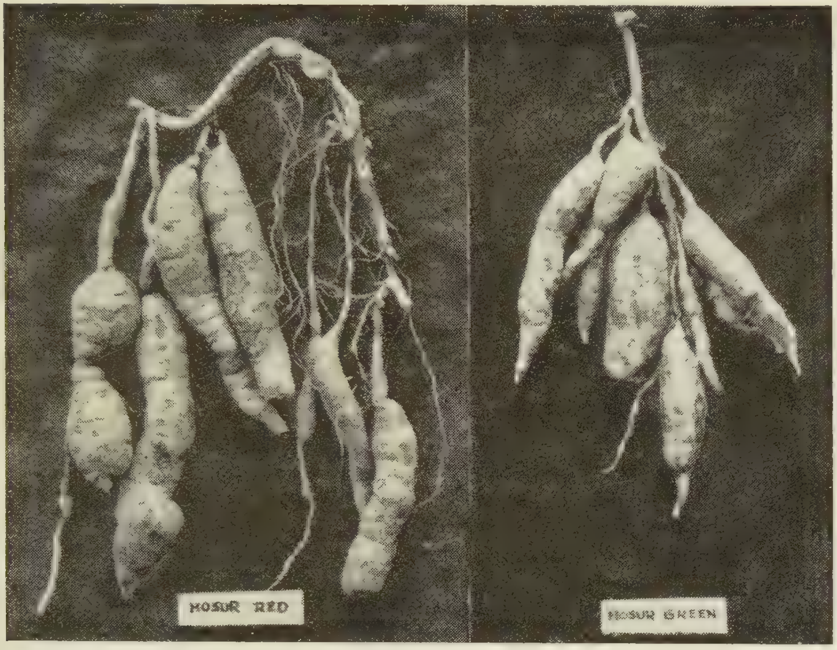
(See Page 47)

PLANTING COCONUT SEEDLINGS


Planted deep
Pit prepared for deep planting of Coconut seedling
Pit prepared for shallow planting in water-logged areas
G
L
½'
2'
1'
1. Clear space ½'
2. Red earth & sand 2'
3. Rubble & sand 1'
G
L
Red earth & sand 2'
Rubble & sand 1'
P.R.R. Pillai

(*See Page 100*)

TWO PROMINENT SWEET POTATO VARIETIES


HOSUR RED
HOSUR GREEN

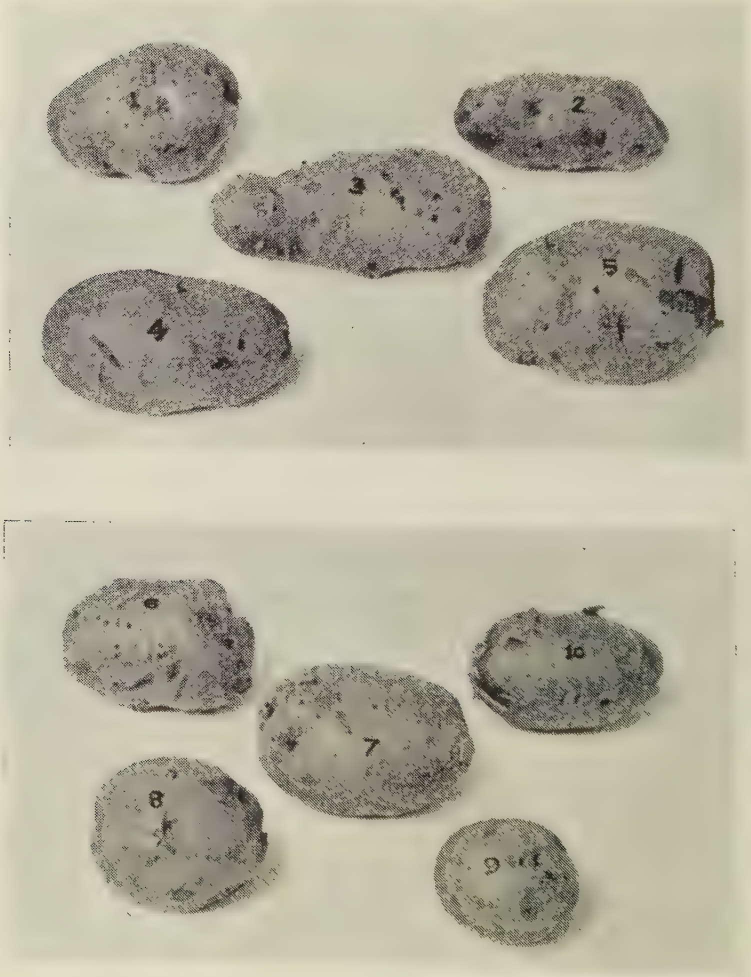
Two of the promising varieties evolved by the Mysore State Department of Agriculture

Left: Hosur Red *Right:* Hosur Green

[*Photo by P. R. Raghuram*

(*See Page 77*)

DUTCH POTATOES IN MYSORE

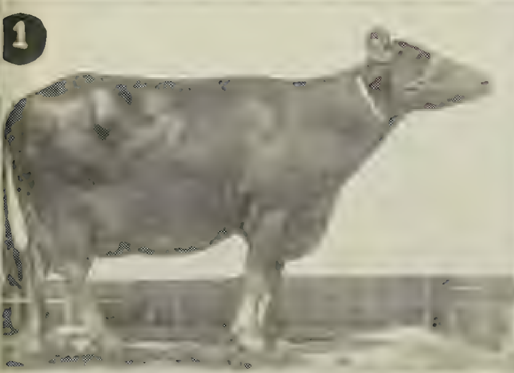


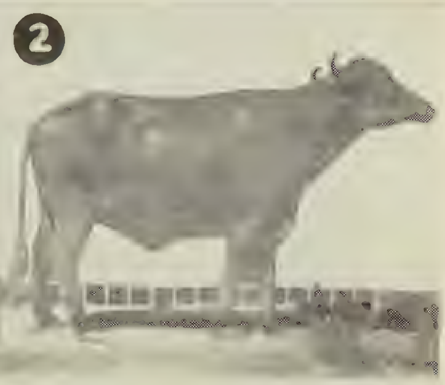
1. Alpha
2. Ultimus
3. Ricket
4. Saskia
5. Eigenheimer
6. Furore
7. Numbri
8. Meerlander
9. Erdgold
10. Bintje

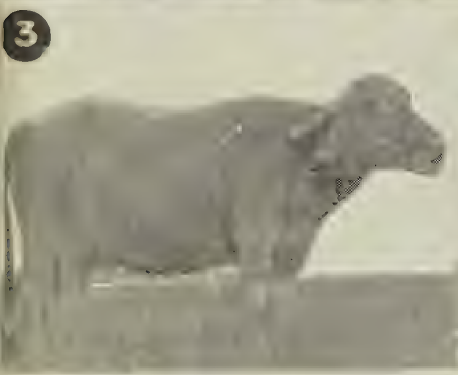
[*Photo by P. R. Raghuram*

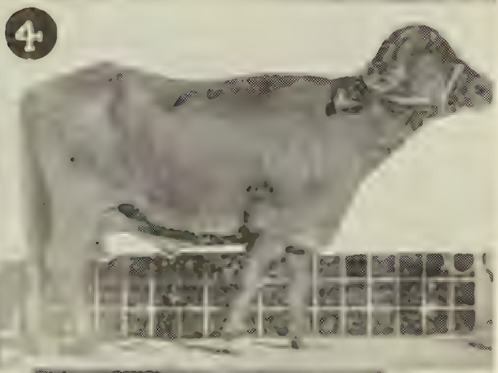
(See Pages 86-87)

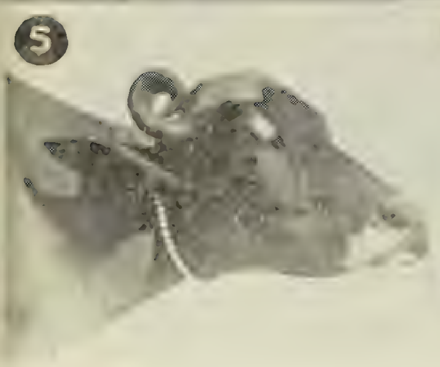
IMPORTANT INDIAN BREEDS OF BUFFALOES

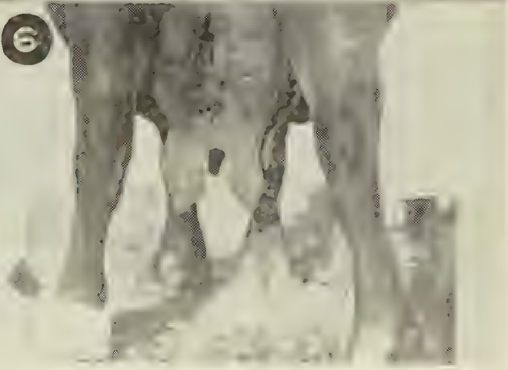








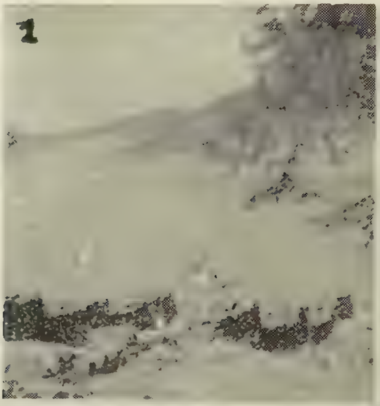


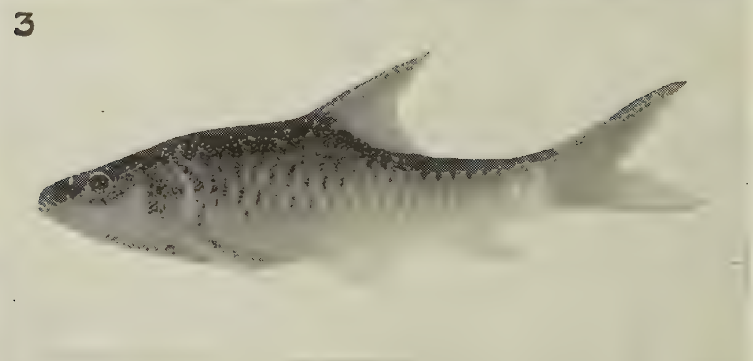


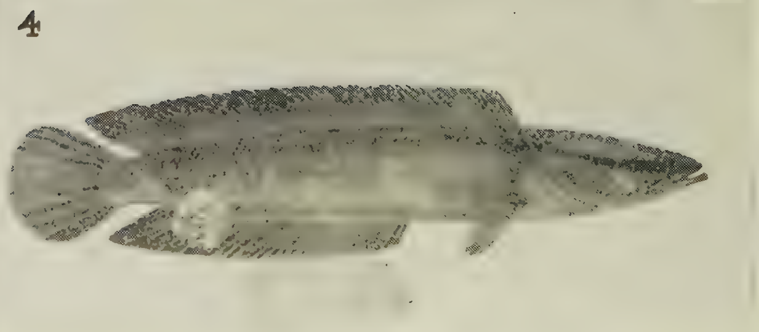
1. Murra
2. Mehsana
3. Surti
4. Jafarbadhi
5. Nili
6. Udder of Nili

[*By Courtesy: I.C.A.R.*

(See Page 191)



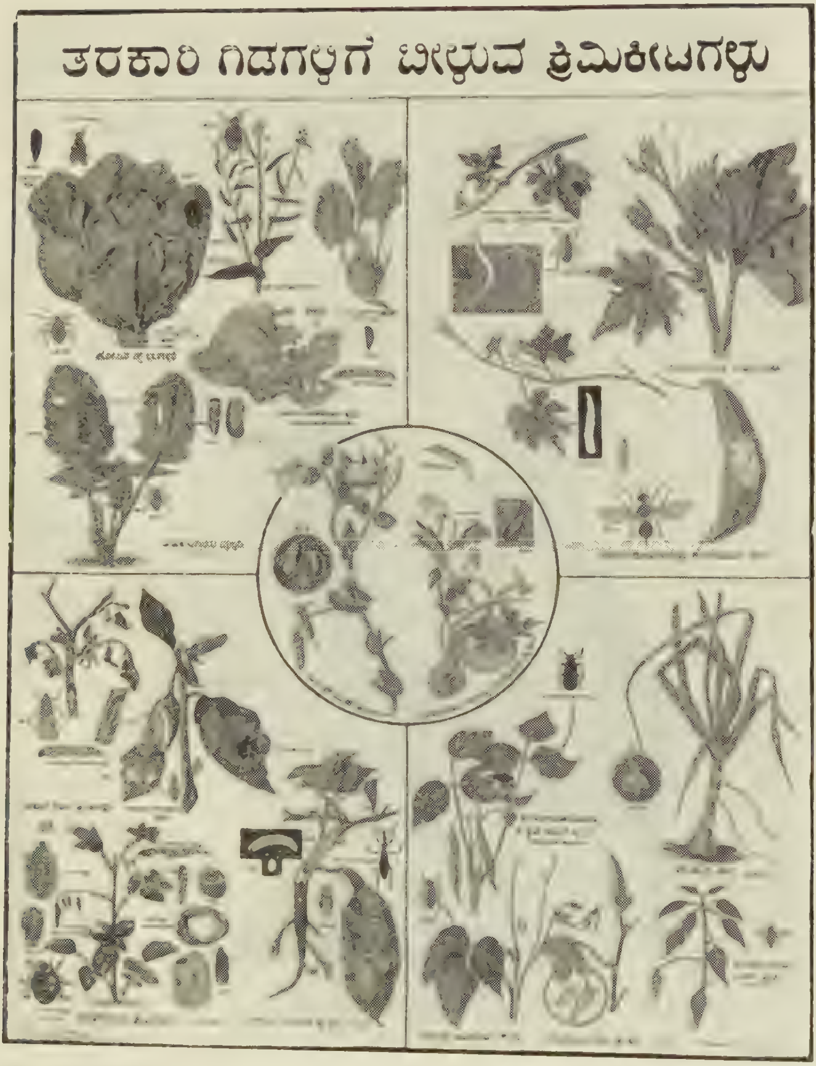




1. *Vanivilas Sagar* in Chitaldrug, one of the biggest reservoirs in the State where a profitable fishery could be developed.
2. *Burude Besthar* Fishermen.
3. Mahaseer (*Barbus tor*).
4. Murrel (*Ophiocephalus striatus*).

(See Page 211)

INSECT PESTS OF VEGETABLE CROPS IN MYSORE

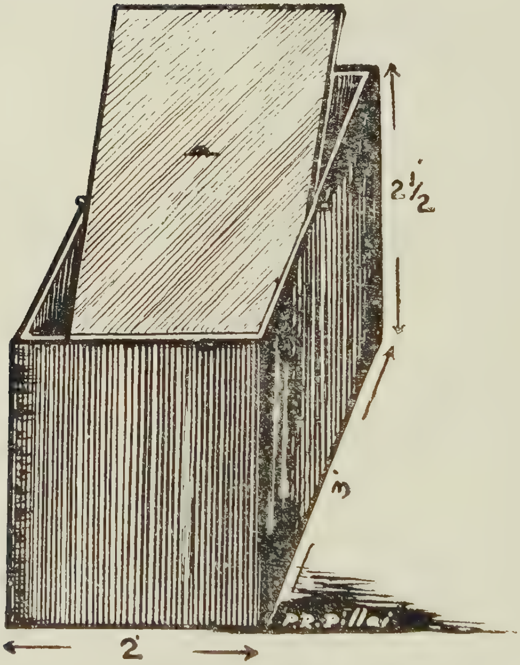


Top left: Pests on cabbage and cruciferous vegetables
Top right: Pests on gourds
Bottom left: Pests on brinjal, potato and sweet potato
Bottom right: Pests on French beans, onion, chilli and okra
Centre: Pests on peas and tomato

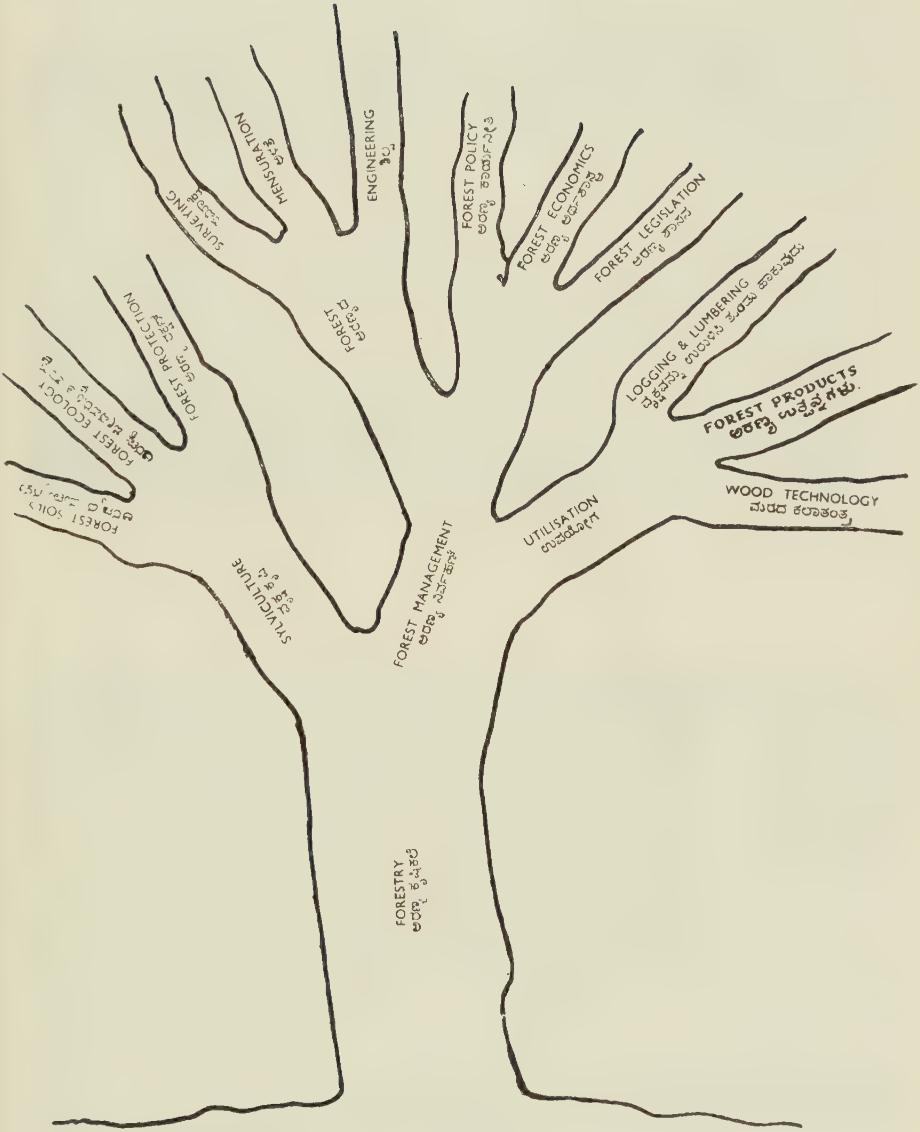
Painted by Vishnudas Ramdas] [*Photo by P. R. Raghuram*

(See Page 116)

RAT TRAP


2½'
3'
2'
P.R.Pillai

TROP SHOWING THE LID TILTED


FOREST SOILS
ಅರಣ್ಯದ ಮಣ್ಣುಗಳು
FOREST ECOLOGY
FOREST PROTECTION
ಅರಣ್ಯ ರಕ್ಷಣೆ
SURVEYING
ಮೋಜಣಿ
MENSURATION
ಅಳತೆ
ENGINEERING
ಶಿಲ್ಪ
FOREST
ಅರಣ್ಯ
FOREST POLICY
ಅರಣ್ಯ ಕಾರ್ಯನೀತಿ
FOREST ECONOMICS
ಅರಣ್ಯ ಅರ್ಥಶಾಸ್ತ್ರ
FOREST LEGISLATION
ಅರಣ್ಯ ಶಾಸನ
LOGGING & LUMBERING
ವೃಕ್ಷವನ್ನು ಉರುಳಿಸಿ ತುಂಡು ಮಾಡುವುದು
FOREST PRODUCTS
ಅರಣ್ಯ ಉತ್ಪನ್ನಗಳು.
WOOD TECHNOLOGY
ಮರದ ಕಲಾತಂತ್ರ
UTILISATION
ಉಪಯೋಗ
SYLVICULTURE
FOREST MANAGEMENT
ಅರಣ್ಯ ನಿರ್ವಹಣೆ
FORESTRY
ಅರಣ್ಯ ಕೃಷಿ

Forestry Tree
(See Page 218)

Properly Managed and Protected Forest Land

(See Page 219)

Lack of Proper Management and Protection " to hastening ills a prey"

(See Page 219)

PESTS (INSECTS, TICKS AND MITES) OF LIVE-STOCK, THEIR GENERAL HABITS AND CONTROL

By M. APPANNA, B.Sc.

Division of Entomology, Mysore State Department of Agriculture

INTRODUCTION

LIVESTOCK are the victims of the attacks by various enemies from the single-celled animal to the most highly evolved one-man. But most of these enemies may be considered to be rather casual in that they have not assumed the status of pests. In the animal kingdom, the insects, mites and ticks play an important part in the development of livestock or any industry which depends on it ; and in almost all the cases the pests cause severe losses to the owner or the State.

A few instances given here will give an idea of the important part played by such pests. In the United States, it is estimated that a loss of about 168 million dollars is sustained every year due to the ravages of these pests on the livestock ; some years back, Britain had to sustain a loss of £ 8,60,000 a year due to sheep blow flies ; and in Australia the same insect was responsible for inflicting a loss of more than £ 4,000,000 a year. Further the animal loss sustained in Canada and Britain mainly due to depreciation in cost of hides damaged by warble flies is estimated at 700,000 dollars and £ 750,000 respectively !

INSECTS, TICKS AND MITES

All these belong to the same Phylum—*Arthropoda*—of the animal kingdom. The insects are characterised by the possession of only 3 pairs of legs—not more or less—in the adult stage and the body in most cases can be distinguished into three distinct divisions. These are all included in the class *Insecta.* Ticks and mites possess 4 pairs of legs and the body is not well-defined as in insects into definite regions. These are classified under *Arachnida.* The common agriculturist, not mindful of the differences between these two types of organisms, styles them as 'insects' mainly guided by the size. As such the term 'pests' or 'insects' is freely used in this article to include the insects, ticks and mites.

THE PEST AND THE HOST RELATIONSHIP

The pests are mostly parasitic depending on the host at one stage or other of their development for feeding and/or breeding. These pests may be external parasites, or internal parasites or intermediary hosts serving as carriers of diseases among livestock or blood-sucking insects or occasional visitors.

The external parasites are those that live in the skin and usually feed on the scales or debris, though few species may pierce the skin and feed on the blood or other fluids. The lice, biting flies, fleas and the ticks are included under this category.

The internal parasites include the larvæ of the 'bot flies' and the like which live in the tissues and organs inside the body of the host.

The ticks, mites and blood-sucking flies are typical examples of pests acting as intermediary hosts in transmitting diseases among livestock. The infectious organism completes a phase of its life-cycle in the body of the intermediary host and later is transmitted to a new host when attacked by this infectious pest. Good examples are the tick fever of cattle and malaria of animals including man. It may also be possible that the pests unknowingly carry infectious organisms from animal to animal and thus serve as mechanical transmitters. The other category of pests are those that feed and breed in open wounds of the animal. Finally there are those that casually visit animals when hungry and feed on the animals by using their stings and styles to good advantage.

NATURE OF INJURY

The nature of injury caused by the pests to the livestock is varied. It may be annoyance to the host, loss of blood, resulting in secondary injuries or mortality of the host.

The most common malady is annoyance. The ecto-parasites bring about this condition in the host. It may be mild when the pests like the lice, crawl on the body of the host or it may be severe when the pests like blow flies and ticks pierce the body of the host. When the annoyance is great, the animal puts in efforts to get over the trouble and thus devotes less time for feeding, etc. It is said that such heavily infested animals feed less and decrease in weight and if they are milching cattle, the milk production is low. Further, the animals become susceptible to diseases which otherwise they would resist.

The blood-sucking flies and certain mites are responsible for loss of blood in livestock when the latter are attacked. As a result of such attacks, the animals become anæmic and susceptible to diseases. Certain insects like the blow flies and warble flies cause irritation to the host animal and it is a common sight to see cattle thus attacked running helter-skelter and suffer subsequent secondary injuries.

These pests play an important part in the transmission of diseases from animal to animal and thereby become responsible for large-scale epidemics. As a result, the livestock industry and its products suffer economically. The few notable examples of insects which cause damage to animal products are the warble flies and ticks attacking cattle hides, the blow flies and lice damaging wool, and screw-worm and lice causing severe losses in the production of mohair in the United States. These significant losses have made it imperative that control measures have to be adopted either as a prophylactic measure to protect the livestock from these ravages or as a curative measure to eradicate the pests if they are already present.

CONTROL MEASURES

The control measures may be classified under the two main heads—*mechanical* and *chemical*. The easiest of the *mechanical* methods is to bestow attention on clean sanitation. This includes cleaning the animals at very short intervals, cleaning their dwelling places daily so as not to give room for any of the pests to breed. In this respect our *ryots* bestow good attention to their cattle, mainly the bullocks and milking cattle. The village dogs are the most uncared for animals. It is rare that one meets a village dog which is not attacked by insects or ticks or mites. This is due to the fact that the service of the dog is considered by the *ryots* to be of secondary importance in their daily life. The other methods which are found satisfactory are screening the animals from infestation, trapping the pests and destroying them, and proper pasture management as not to allow the pests like ticks to pass a period of their life-cycle in the pastures.

The *chemical* method of control is the most modern and widespread. It is applied either to control or to eradicate the several pests that attack livestock all over the world. The early chemicals used were mostly inorganic compounds like the arsenics, fluorides, sulphur, etc. Arsenic has held its sway in this field even now when organic compounds like BHC and DDT have replaced them. The early organic compounds used were the mineral oils and certain tar distillates. But in most cases their uses were limited in that they were found to be toxic to the hosts.

The modern insecticides like BHC and DDT and others like methoxychlor and chlordane, etc., have been found to be good, and with a little care they can be used in the control of the pests of livestock. Chlordane is considered to be the most toxic of all these insecticides. Of the two insecticides BHC and DDT, the former has greater potency to give a ready kill of the pests with less degree of residual effect than DDT, which, though slower in its initial action has longer and better residual effect than any other insecticide. The concentrations at which these chemicals BHC and DDT are to be used vary with regard to each pest and host and it is always advisable to use them under the guidance of a veterinary doctor.

BHC and DDT are used in the form of dusts against most of ecto-parasites. It has been found that DDT is stored in animal fat, and in milk of cattle and thus constitutes a constant danger to human beings who feed on such food. In most of the countries DDT is being replaced by methoxychlor which is claimed to be less toxic to animals. Gammexane is observed to leave a taint in the tissues on which it is either rubbed or used. These insecticides are mostly useful in keeping down the pests in their breeding places in dwelling places of the livestock. These two insecticides are effective against the flies, mosquitoes, fleas, etc. Both these insecticides are not soluble in water. In countries where livestock farming is developed as an industry, plunge dips are constructed and the animals are given a periodic dipping to ensure protection against the blow flies, ticks and such like pests.

The following extract from "Insects Affecting Livestock" by Roberts gives an idea of the importance that is attached to this method of control to combat the pests on cattle and sheep.

"Within the cattle areas, plunge dips of 2,000-3,000 gallon capacity have been built at strategic points, so spaced that cattle have only short distances to walk for treatment. To the cost of constructing dips and the cost of the insecticides with which they are filled must be added that of mustering the cattle for treatment. In heavily infested areas and during the season of tick activity, some properties spend as much as 90% of their time in mustering and dipping to control ticks. The infested States have also to maintain large staffs and many dips to prevent the ticks from spreading, and in New South Wales alone this costs in the vicinity of £ 450,000 per annum.

In the case of sheep blow fly, the cost of crutching, jetting, the modified Mules operation, and the frequent mustering and dressing of sheep during outbreaks must all be charged against blow flies."

There are also insecticides of plant origin like pyrethrum, rotenone, nicotine, etc. These insecticides have a good range of insecticidal properties and except nicotine are not toxic to animals in the concentrations in which they are used. It may be said that with good and proper attention and judicious use of insecticides under technical guidance livestock may be protected against the ravage of the common pests.

SOME COMMON PESTS OCCURRING IN SOUTH INDIA

As already stated above, most of the common pests belong to the order Diptera under the class *Insecta*, and the ticks and mites to the class *Arachnida*. The list is by no means a complete one and only few examples are given to give an idea of the habits of the pests.

The insect pests are the different kinds of flies, fleas, lice and the like and occasionally wasps and hairy caterpillars. Of these the fly pests play a very important part. They are classified as Gad flies (Tabanidæ), horse flies (Hippoboscidæ), Bot flies (Oestridæ) and those that are included under Muscidæ and Culicidæ.

The Gad Flies (*Tabanidœ*).—The adults are active, the males having well developed large eyes. The females are a scourge to cattle and suck the blood from them while the males feed on nectar of flowers. The eggs are laid in clusters on grasses in marshy areas. The emerged larvæ wriggle in the marshy soil and possess a rounded body pointed at both ends with ridges across the body ; their food consists of minute organisms in the soil. The larvæ pupate near their place of abode and emerge as adults. *Tabanus striatus* Fab. is the common species occurring in South India as pest of cattle.

The Horse Flies (*Hippoboscidœ*).—The adults are well-built yellowish brown to red-coloured flies with spots or bands on the body and possessing strong claws, at the end of their legs, with which they attach themselves to the host and feed on the host blood. These do not fly but hover for a short time and alight on the same host. The adults bring forth fully developed grubs which pupate within a very short interval. The common forms are *Hippobosca maculata* Leach., found attacking cattle and *Hippobosca capensis* Oli., generally found on dog.

The Bot Flies (*Oestridœ*).—This includes the horse bots, ox warbles and the sheep bots. The maggots feed on the internal tissues of the host and are responsible for transmission of diseases, etc. Of the three, only the sheep bot (*Oestrus ovis*) is of common occurrence in South India. The maggots get entry into the nasal chambers of the sheep and when in large numbers cause annoyance to the host. The ox warble, *Hypoderma lineatum* de Vellers., and the horse bot, *Gastrophilus equii* F., are not frequently seen in South India. They cause the same type of annoyance to cattle and horse respectively. The ox warble lives in the subcutaneous regions in swelled pouches of the skin which is the result of attack by this maggot. The damage caused by ox warble is economically significant in that the milching cattle yield less milk and the damaged hides fetch a low price.

The Blue Bottles (*Muscidœ*).—These flies are usually bright coloured and belong to the same genus as the house fly. The young ones develop in decaying matter of vegetable and organic origin, pupate in the soil and emerge as adults. In general, these flies attack animals which have open wounds on their bodies and later become responsible for the transmission of diseases amongst the livestock. The common examples are *Pycnosoma flaviceps* Mass., *Musca nebulo* Fb., and *Musca pattoni.*

The Flesh and Biting Flies (*Sarcophagidœ*).—These flies look the same as the Muscidæ except for the possession of a piercing proboscis with which they pierce the host body and suck the blood. The most common example is the stable fly—*Stomoxys calcitrans* L., which is found breeding in horse and cattle dung and attacking horses and cattle.

The mosquitoes (Culicidæ) are also blood-sucking flies and are usually carriers of diseases among livestock including man.

The lice are the next important group of insects which attack livestock. These insects are commonly met with infesting human beings and being responsible for the several maladies with which they suffer. They are generally found attacking poultry. They possess biting and sucking mouth parts and this damage caused is by cutting the skin, debris and feathers. The common bird louse attacking the poultry is *Menopon pallidum* N. In South India the common louse recorded on cattle is *Hœmatopinus tuberculatus*, which lives in the ear lobes of the host. Though not a serious pest this louse has been observed to cause annoyance to the host and make it anæmic by sucking the blood.

The fleas are mostly carriers of diseases from animal to animal and thus play an important part in the well-being of livestock including man. The adults fix themselves to the host and suck blood. The larvæ are minute smooth worm-like and usually feed on the organic matter in the soil. The pupa is in a small cocoon. The common examples met with in South India are Fowl flea—*Echidnophaga gallinaceus* Westw., the Rat flea—*Xenopsylla cheopis* Roth., and the Dog flea—*Ctenocephalus felis* Bouche. It may be that the fleas may carry the infectious organisms directly from animal to animal or through an intermediary host.

The ticks and mites belong to the class *Arachnida*. In addition to the difference in the position of the stigmatal plates, the two forms may be distinguished by their size. The ticks are comparatively large in size and usually possess a leathery integument. These are invariably ecto-parasites and are responsible for various types of damages to the host, and ultimately to the industry. The most important of these is the spreading of diseases among livestock. The common mite met with in South India is *Psorptes communis* F., which is responsible for mange and scab in dog. The infested portion swells and itching sensation starts. The itching increases gradually and pustules appear. These pustules become continuous and the exuding serum forms a scab. If the infestation is severe the animal becomes anæmic and in most severe cases the animal dies. The poultry tick—*Argas persicus* F.; the dog ticks belonging to the genera *Rhipicephalus* and *Boophilus*; and the cattle and horse tick belonging to the genus *Hyalomma* are few examples of ticks found in South India and which are responsible for transmitting diseases from host to host in addition to the annoyance they cause to each host.

INSECT FRIENDS OF MAN

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INSECTS are not all bad. Their destructive role is so obvious that we are likely to forget their beneficial attributes and habits. The interesting facts of silk, honey and lac production, the intricate mechanism of flower pollination, the good that results from insect predators, parasites and weed-killers, and the activities of insect soil builders and scavangers—all are topics that deserve our earnest consideration.

1. PRODUCTIVE INSECTS

(1) *The Silkworm,* Bombyx mori *Linnæus* (*Bombycidæ, Lepidoptera*).—"This insect has been a creature of domestication from time beyond memory and history, a captive and slave to man. For more than 35 centuries it has toiled ceaselessly for man; countless generations laying their eggs, eating the mulberry leaves provided for them in the larval stage, spinning their cocoons, and then dying—a perpetual sacrifice to the demand of men and women for adornment." The silk industry originated in China, where for more than 2,000 years the source of silk was kept a closely guarded secret; any attempts to take eggs or silkworms out of the country being punishable with death. However, about 555 A.D., two monks smuggled some eggs "concealed in a staff" and took them to Constantinople. In this humble way sericulture was introduced into Europe.

The moth is ashy-white, with a fat body and a wing expanse of about 2″. It takes no food and seldom flies. Soon after mating, the female moth deposits 300-400 round, yellowish eggs, which turn gray. Incubation period is about 10 days. The young larva is tiny (1/8″ long), grayish or creamy in colour. The full-grown larva is about 3″, grayish white, hairless, with a hump on the neck and a spine-like horn at the tail. It is a voracious feeder, mulberry leaves being used entirely as food. The larval life occupies about 1-1½ months and there are 4 moults. At the final stage, the larva becomes restless, and soon begins to spin a cocoon which occupies 3 days. The cocoon is oval, from white to a beautiful golden yellow, formed from the larval saliva that hardens upon exposure to air into a continuous fine silk fibre. Within the cocoon the larva changes to a pupa. In about 15-20 days it transforms to a moth, which secretes an alkaline fluid that softens one end of the cocoon, through which it escapes.

The pierced cocoons, from which moths have emerged, cannot be reeled, but are carded and made into thread, which fetches a low value. The cocoons, about 10 days after their formation, are therefore dropped into hot water, which kills the pupæ avoiding the injury of moths and also softens the gum that binds the silk threads together. The silk fibre is then skilfully unwound, the threads from several cocoons being wound together on wheels to form the reels of raw silk. It is estimated that the filament in each cocoon ranges in length from 800-1,200 yards, and that it requires more than 25,000 cocoons, and the consumption of about a ton of mulberry leaves, to produce a pound of silk. At least 1,000 billion silkworms produce from 50,000,000-70,000,000 lb. of raw silk, which is marketed each year. Sericulture is now an important and flourishing industry in China, Japan, India, Italy, France and Spain.

Many kinds of wild silk moths, *e.g.*, the Tassar (*Antherœa paphia* B.) and the Eri (*Attacus ricini* B.) (Saturnidæ, Lepidoptera), spin cocoons, but *B. mori* is the one species that has been domesticated and cultivated on a large scale for obtaining the silk of commerce. The South Indian silkworm is *Bombyx mori* var. *meridionalis,* which is a polyvoltine race passing through many broods in the year.

(2) *The Honey Bee.*—Three species of honey bees, *Apis indica* Fabricius, *A. dorsata* Fabricius and *A. florea* Fabricius (Apidæ, Hymenoptera) yield honey and bees wax. Of these, only *A. indica* has been domesticated. Plants secrete nectar (sugar-bearing secretions) in profusion but in very minute quantities. In order to provide food for the young and to build up stores for winter, the bees repeatedly and tirelessly visit the flowers and gather the nectar and store it in small six-sided wax cells constructed by them in the combs. It is a very hard task indeed, since to gather 1 lb. of honey it requires from 40,000-80,000 visits to as many number of flowers, of a honey bee, which at the rate of 1-1½ miles per trip works at twice the distance around the world! The nectar that is swallowed by the bees further undergoes chemical changes due to the intermixture with the saliva and the sucrose (the cane sugar) is hydrolysed to glucose (grape sugar) and fructose (fruit sugar), the latter "invert" sugars being more readily assimilated by man. Honey is a rich and wholesome food, largely used in confectionary, food of deep sea divers and in the dietetics of diabetic persons.

The bees also produce bees wax, which is extensively used in industry and arts. It is a natural secretion of the abdominal glands of worker bees given out in thin flakes. Its production follows the digestion of honey, a pound of wax resulting from the consumption by the worker bees of 3-20 lb. of honey in about 24 hours. The bees construct combs with the wax, in which honey is stored and the young reared.

A honey bee colony may contain 50,000-60,000 individuals, comprising three forms: (*i*) *Workers*: Imperfectly developed females, who form the bulk of the colony. Except reproduction, they perform all the duties of the colony, such as pollen and nectar collection, wax production, cleaning and guarding the hive, tending young ones, etc.; (*ii*) *Drones*: Males, somewhat larger and darker than the workers devoid of stings and few in number. They are plentiful at the swarming time, after which they are driven out of the hives; and (*iii*) *Queen*: Females, large and golden yellow in colour, and her sole duty is egg-laying. A queen may lay about 10,00,000 eggs during 2-3 years of her life. Eggs are placed in clean and polished cells at the bottom of the comb. In about 3 days they hatch into small, shining white legless grubs. The cells are capped by the workers, and the larvæ spin thin cocoons and pupate in about 12 days. The pupal stage lasts about a week, after which the daughter bees cut out the cell caps and emerge out.

(3) *The Lac Insect*: Laccifer (Tachardia) lacca *Kerr*. (*Coccidœ, Hemiptera*).—The lac industry is ancient and goes back to several thousand years. In 1709 Tachardo described the species. It is a scale insect, breeding in great abundance on the forest trees, on which it is sometimes cultivated. The minute young crawler settles on a twig, and feeding on its sap grows and secretes a resinous covering. Thousands of such crawlers congregate on a twig and their secretion forms a thick encrustation. The crawlers develop in about 3 months. The males emerge out but the females continue to live within the resinous mass and are fertilised by males which enter through small openings in the encrustation. The eggs develop within the body of the mother, which is now a bright red sac. Soon the mother dies, the eggs hatch and the crawlers escape and infest new twigs.

It is estimated that nearly 1,50,000 lac insects produce a pound of lac. About 40 million pounds of stick lac is collected annually. The encrusted twigs, commonly known as stick lac, are harvested in June and November and pounded in crude mortars. The resulting granular lac—seed lac—is washed, melted and dried in thin layers, which form the lac of commerce. The fine particles are moulded into toys and ornaments. Lac is used in the preparation of varnishes, polishes, inks, sealing wax, phonograph records, insulating electrical material, airplanes, etc.

(4) *The Cochineal Insect*: Coccus cacti *Linn*. (*Coccidœ, Hemiptera*).—This scale insect thrives on prickly pear, *Opuntia coccinellifera*. Cochineal, a carmine red dye, is obtained from the dried and pulverised bodies of the cochineal insect. It is nowadays used mainly in cosmetics, confectionery and beverages. Prior to the discovery of the aniline dyes, it was largely used in textiles. The cochineal insect is now cultivated principally in Honduras, the Canary Islands and Mexico.

Minor Productive Insects.—Cantharidin, used for medicinal purposes, is secured from the dried bodies of a European blister beetle, *Lytta vesicatoria* Linn.

Galls are malformations produced by insects. Some galls are used as a source of dye, and tanning materials and for medicines. The Aleppo gall, produced by a wasp-like insect, in Western Asia and Eastern Europe has been used as a dye, tonic and astringent and in the preparation of inks.

II. INSECTS AS POLLINATORS

Insects are a very important pollinating agency. Thrips, butterflies, moths, ants, beetles, flies, wasps and bees all share in this work. The cross-pollination of most of the fruits and ornamental flowers, vegetables, such as beans, peas, tomatoes, melons, etc., field crops like cotton, tobacco, etc., depends entirely on insects. Flowers which are pollinated by insects generally are conspicuous, beautifully coloured or emit fragrant odours and have nectaries and sticky pollen grains and stigmas. They serve to attract insects. Insects also have many remarkable structures adapted for this purpose, the common examples being thick hairs, hair brushes, pollen baskets, long proboscis, etc.

Honey bees are now recognised as more important in fertilising crops than in the production of honey. No less than 50 vegetable and fruit crops, such as plums, apples, cherry, pear, cotton, clover, onions, beans, carrots, etc., depend on honey bees for pollination. In U.S.A. intensive cultivation of land and the general use of synthetic insecticides are rapidly eliminating natural pollinating insects. More attention is therefore being given to the use of honey bees, which are now estimated to be responsible for nearly 80% of the insect pollination of commercial crops. In fact, crop industry depends for pollination on honey bees hired from bee-keepers during the blossoming season. Co-operation between a grower and a bee-keeper has thus become important and is mutually advantageous.

The wild bees, next to the honey bee, are the important pollinators. Bumble bees were introduced into New Zealand at the end of the 19th century to pollinate red clover; leaf-cutting bees (Megachilidæ) are generally credited with the most of the pollination of alfalfa in Canada; and several small species of sweet bees appear to aid in the pollination of beets in Utah.

The failure of smyrna fig cultivation before the introduction of the pollinating fig wasp (*Blastophaga psenes* Linn.) (Chalcididæ, Hymenoptera) in California is one of the outstanding examples of the dependence of plants on insects.

III. BENEFICIAL PREDATORS AND PARASITES

The control of animal and plant pests by insect predators and parasites and microbial organisms is known as *Biological Control.* When successful, it is a natural, self-perpetuating and permanent remedy. The predators attack and devour wholesale or large part of their prey. The common economic predatory insects are the praying mantids, dragon flies, damsel flies, aphis lions, ground beetles, lady beetles, syrphid flies and robber flies. The Economic Entomologists are always in search of more suitable of these predators, and wherever possible, employ them to the best advantage of the agriculturists by artificial colonisation.

The vedalia, *Rodolia cardinalis* Mulsant (Coccinellidæ, Coleoptera) is the classical example of a predatory beetle, which was successfully introduced from Australia into California in 1889 for the control of the cottony cushion scale, *Icerya purchasi* Maskell, which once threatened to ruin the citrus industry. This insect has subsequently been introduced into Hawaii, New Zealand, Egypt, and more recently into India including Mysore.

Cryptolœmous montrouzieri Mulsant. is another Coccinellid beetle introduced from Australia into California in 1892 for the control of the citrus mealy bug, *Pseudococcus citri* (Risso). This important predator was later introduced into France, Italy, Egypt, Hawaii, Philippines and India. Recently (1951) it was discovered in Bangalore where it is well established and is common on mealy bugs of different fruit crops like guava, mango, citrus, etc.

Coccinella septempunctata Linn. and *Chilomenes sexmaculata* Fabricius are our most common natural predators destroying very large numbers of aphids of various cereal, vegetable and fruit crops season after season.

The two giant *Coccinellids—Synonycha grandis* Thunb. and *Anisolemnia dilatata* Fab., employed in the biological control of sugarcane aphids in China and Far Eastern countries, *Chilocorus nigritus* Fabr., an important predator of the coffee green bug, *Lecanium viride* Green, and numerous other new predators are present in Mysore and are being studied by the Division of Entomology (Mysore).

Parasites.—Of the several orders of insects containing parasitic species, the wasps (Hymenoptera) and the flies (Diptera) are the most abundant and important. The parasites attack the host insects in all stages of development. Usually the parasitic larva feeds on the tissues and develops within the host, after which the latter dies. A number of insect parasites has been employed with conspicuous success in California, Hawaii, New Zealand, Fiji and Canada. The more popular examples are the following :

Country	Parasite	Host	Remarks
New England	*Anastatus disparis* Ruschka *Apanteles melanoscelus* Retz.	The gipsy moth, *Porthetria dispar* Linn.	Appreciable succe
	Campsilura concinnata Meig. *Sturmia nodicola* Townsend *Apanteles lacteicolor* Viereck	The brown tail moth, *Nygmia Phæorrhæa* Don.	do
Massachusetts	*Chætexorista javana*	The oriental moth	Effective
Utah	*Bathyplectes curculionis* (Thompson)	The alfalfa (lucerne) weevil, *Hypera postica* Gyllenhau	Fairly satisfactory
Mid-Atlantic and N. Central States New England	*Lydella stabulans grisescens* *Macrocentrus gifuensis*	The European corn borer *Pyrausta nubilaris*	
California	*Apanteles medicaginis* Muesebeck	The alfalfa caterpillar, *Colias Philodia eurytheme* Boisd.	Effective
do	*Metaphycus helvolus* Comp.	The citrus block scale, *Saissetia oleæ* (Bern)	Successful
do	*Coccophagus gurneyi* Comp. *Tetracnemus pretiosus*	The citrophilous mealy-bug, *Pseudococcus gahani* Green	do
Canada	*Microplectron fuscipennis* Zett.	The spruce sawfly *Diprion polytomum* Htg.	
Fiji Is.	*Ptychomia remota* Ard.	The cocoanut leaf-moth *Levuana irridescens* Baker	
	Pleurotropis parvulus Ferriere	The leaf-mining beetle, *Promecotheca reichei* Baly	
	Tetrastichus brontispæ Ferriere	*Brontispa* Sp.	
Hawaii Is.	*So ætrastichus beatus* Perk.	The sugarcane leaf-hopper, *Perkinsiella saccharicida* Kirk.	Partial, complete control effected by a predaceous bug, *Cyrtorhinus mundulus*
do	*Opius humilis* Silv. *Diachasma tryoni* Cam.	The Mediterranean fruitfly, *Ceratitis capitata* (Wied)	
do	*Opius fletchri* Silv.	The melon fly, *Dacus cucurbitæ* Coq.	

In India, the Mysore Division of Entomology were the first to establish in 1935 a parasite laboratory at Mandya, where millions of local *Trichogramma evenescen minutum* Riley are reared on the eggs of the rice moth, *Corcyra cephalonica* St., and released annually against the sugarcane moth-borer *Chilotræa infuscatella* Snellen. Though this parasite has received mixed reception in other parts of the country, it has proved very useful in Mysore State. *Trichospilus pupivora* Ferr., *Perisierola nephantidis* Mues., *Elasmus nephantidis* Rof. and *Microbracon brevicornis* Wesm. are similarly being bred in Madras State and released in bulk against the coconut leaf-minor, *Nephantis serinopa* Meyr. *Aphelinus mali* Hald. was successfully introduced from England into the Panjab for the control of the apple root aphid, *Eriosoma lanigerum* Hauson; *Microbracon gelechiœ* Ashmig. was similarly imported from U.S.A. into Delhi for the control of the potato tuber moth, *Gnorimoschema operculella* Zeller. Introductions of foreign parasites have been made by the Forest Research Institute, Dehra Dun, with teak defoliator, *e.g., Apanteles malevolus, Cedria parodoxa* and *Dioctes gardneri* in South India and Burma ; and with Shisham defoliator, *e.g., Disophrys sissoo* and *Microgaster plecopterœ* in the Punjab.

At present the Mysore Division of Entomology are engaged in the mass multiplication of some important indigenous parasites such as *Pleurotropis foveolatus* against the potato *Epilachna, Microbracon hebetor* Say. for the control of *Adisura atkinsoni* Moore, *Sesamia inferens* Walk., etc., and *Tetrastichus ayyari* Rohwer which is a common pupal parasite of many Lepidopterous crop pests.

IV. INSECT WEED-KILLERS

Prior to 1927 the prickly pear, *Opuntia dillenii* Haw. and *O. nigricans* Mill., had invaded millions of acres in South India, and in some parts it so densely covered as to make the land impenetrable. All attempts at mechanical, cultural or chemical control failed. Therefore the cochineal insect, *Dactylopius tomentosus* L. was imported from Ceylon in 1927 simultaneously in Mysore and Madras, and it soon established itself and the control of the noxious weed was realised. The results have been most spectacular, in that the cochineal insect is self-perpetuating and spreads automatically and has effectively and permanently controlled the prickly pear during these 25 years.

Similar spectacular control of weeds has been recorded in the case of four other insects—*Cactoblastis cactorum* (Berg.), which completely destroyed another species of prickly pear, *O. monocantha* in Australia, the two Chrysomelids *Chrysolina hyperici* Forst. and *C. gemellata* Rossi in the control of St. John Wort, *Hypericum perforatum* in U.S.A. and the seed weevil *Apion ulicis* Forst. against the gorse, *Ulex europœus* in New Zealand.

Partial control of the lantana has been obtained in Hawaii by *Agromyza lantanœ* Frogg, *Crosidosema lantanœ* Busck. and *Teleonemia scruplusa* Stal. (= *Lantanœ* Dist.). Importations of the Agromyzid fly from Hawaii into Mysore in 1921 and 1933 have not so far yielded successful results, although the fly is well established here. Recent investigations by the Forest Research Institute, Dehra Dun, have shown that *Teleonemia* bug also is unsuitable on account of its polyphagus attributes and low controlling capacity.

V. INSECT SOIL BUILDERS AND SCAVENGERS

Aeration of the soil is secured through the burrows of ants, termites, grubs, beetles, etc. Many insects turn over the soil, and tear to pieces fallen leaves, twigs, trees, etc., which hasten their decay and enrich the soil. Some insects hasten the decay of animal bodies and their return to the soil. The soil so enriched by the plant and animal matter, provides nutrients for other plant growth. "Thus the insects figure in the endless cycle that involves all life."

VI. INSECTS IN MEDICINE

It has already been mentioned that certain insect products like the Aleppo gall and cantharidine are used as tonic, astringent and for other medicinal purposes.

Therapeutic Myiasis.—As early as the 16th century, Paré had noted the very satisfactory healing of infected wounds in which larvæ of blowflies had become established. Larry, surgeon to Napoleon, made similar observations during the Syrian campaign. World War I, with its emphasis on trench warfare, furnished many examples of wounded soldiers whose wounds, when fly blown, were in a better condition than those of others. In the period following World War I, therefore, maggot therapy of certain traumatic conditions, particularly in chronic osteomyelitis, became very popular. Subsequent researches have shown that allantoin and urea are produced by the maggots and that both these substances have marked healing properties. Ammonium bicarbonate, another product of maggot metabolism, has the very desirable tissue-stimulating qualities. It is also pointed out that bactericidal substances capable of destroying hemolytic streptococci are also given off in the natural excretions of the maggots. The most suitable species for use in maggot therapy are *Lucilia sericata, L. cæsar, Phormia regima* and *Wolhfahrtia nuba*. The use of *Musca domestica* is confined largely to Europe. In recent years, however, the use of maggots has been rather generally abandoned in favour of direct treatment with allantoin urea and ammonium carbonate, direct treatment being considered more satisfactory as it avoids search for suitable and harmless maggots and the tedious task of maintaining sterile colonies and direct injury by larvæ, etc.

INSECT TRANSMISSION OF PLANT DISEASES

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RESEARCHES during the last fifty years have brought to light many insects that play a vital role in the spread and development of several plant diseases caused by three very important parasitic micro-organisms—*viruses, bacteria* and *fungi*. The problem of insects in relation to plant diseases is of a complex nature, as it is a biological phenomenon, with economic implications, arising from a long, highly organised and very close association of insects and micro-organisms.

INSECTS AND PLANT VIRUSES

Viruses are an amazing group of minute entities, which are invisible under the ordinary microscope and are commonly recognizable only by the symptoms of disease they cause in the plants. Little was known about the nature of viruses prior to 1935, when Stanley, an American Bio-chemist, followed by other workers, pointed out that they consisted of complex nucleoproteins. The viruses exhibit a very important attribute of the living organisms, namely, reproduction and multiplication within the living cells of their hosts ; however, other metabolic functions like respiration, digestion, etc., have not been observed.

In India many of the crop plants are attacked by virus diseases, and the damage is sometimes substantial. Mosaic and streak diseases of sugarcane, cardamom mosaic (*katte*), leaf-curl of tobacco, potato virus diseases, groundnut rosette, and virus diseases of beans, pigeon peas, sannhemp, cotton, tomatoes and papayas are common examples. In the United States and Europe the viruses cause some of the most destructive diseases of agricultural crops, notably among which being phoney peach, peach yellow, aster yellow, sugar-beat, curly top, tobacco mosaic, potato leaf-roll, etc. The viruses also cause serious diseases of man and animals—small-pox, measles, mumps, the common cold, rabies, foot and mouth diseases, etc.

The common symptoms of virus infection in the plants are—(1) *Chlorosis*—development of green patches on leaves, stunted growth and dwarfing of affected plants ; (*ii*) *Mosaic*—leaves develop spots, patches, rings, streaks or other patterns of light green presenting a mottled appearance ; (*iii*) *Yellows*—yellow appearance, the chlorosis being general throughout the leaves, but no mottling ; (*iv*) *Necrosis*—groups of cells in diseased plants collapse and die. *Necrosis* occurs both in stem and leaves and viruses of necrotic type are common in the potato plants ; and (*v*) overgrowths, such as galls or enations (sannhemp mosaic), fruit deformities (cucumber mosaic) stunting and dwarfing of plants (brinjal mosaic). Virus diseases seldom kill the plants, but affected plants never recover and their growth and productivity are seriously affected.

Among the various transmission agents of virus diseases like seeds, cuttings, wind, water, soil, contact, etc., insects are the worst spreaders. The first proof of insect transmission of a virus disease was recorded in 1901 by Takami, a Japanese scientist, who showed that the dwarf disease of rice was brought about by the leafhopper, *Nephotettix apicalis* Motsch. In 1906 Ball demonstrated that curly top of sugar-beets in North America was associated with another leaf-hopper, *Eutettix tenelles* (Baker). Allard in 1912 showed that a virus disease of tobacco was transmitted by aphids. These discoveries of fundamental significance marked the beginning of a new series of fruitful investigations that has shown the great importance of insects as vectors of a large number of virus diseases. At present, insect vectors of plant viruses are known to occur in five important orders of insects, *viz.*, Hemiptera (aphids, leaf-hoppers, plant bugs, mealy bugs), Thysanoptera (thrips), Coleoptera (beetles), Orthoptera (grasshoppers) and Dermaptera (earwigs). Among these, aphids and leaf-hoppers seem to be the most proficient.

During the feeding process the insect vector gets the virus from an infected plant and transmits it to healthy plant. In some insetcs this ability to cause new infections is quickly lost—*non-persistent viruses,* generally transmitted by aphids and chewing insects. In other cases, which are known as the *persistent viruses,* when they are taken in with the food of their vectors, an interval (*incubation* or *latent period*) is necessary before the insects can infect healthy plants with them. Insect carriers of persistent viruses can usually transmit them for an extended period, often for life. Most of the viruses that leaf-hoppers transmit are persistent viruses. Whether the virus undergoes development or reproduction within the insect vector during the incubation period, or is it merely the time necessary for the virus particles to travel through the different systems of the insect before they reach the salivary glands for introduction with saliva into healthy plants during feeding, is not conclusively proved. A single virus disease may be transmitted by several insect species, or a single insect may transmit several diseases. Viruses do not seem to affect their insect carriers in any way, even though they cause serious diseases of plants.

Examples of Plant Viruses and Some of Their Insect Vectors

Virus (Pathogen)	*Vector* (Insect)	Host plant	Remarks
Mosaic ..	*Pentalonia nigronervosa* (Aphididæ, Hemiptera)	Cardamom (*Elettaria cardamomi*)	A serious disease resulting in early death of plants in South India. Mottled leaves and stunted growth are the common symptoms
Bunchy top ..	do	Plantain	South India
Leaf-curl ..	*Bemesia gossypiperda* (Aleyrodidæ, Hemiptera)	Tobacco	Serious throughout India. Leaves badly curled, twisted and distorted and therefore market value reduced
do ..	do	*Ageratum conyzoides* and other weeds	
Little leaf ..	*Empoasca devastans* (Cicadellidæ, Hemiptera	Brinjal	Observed in South India. Leaves greatly reduced and stunted growth of the plant
Mosaic ..	Insect vectors rare In India	Sugarcane	Minor importance; occurs throughout India. Infested plants usually recover
Streak ..	do	Sugarcane	do

Mosaic disease of cucurbits, groundnut rosette, different virus diseases of potatoes, virus diseases of beans, pigeon peas, cotton, chillies, tomatoes and papaya are common, but only a few of them have so far been investigated in India.

INSECTS AND BACTERIAL DISEASES

Bacteria are the smallest plants without chlorophyll, but with a saprophytic or parasitic mode of life. The plant pathogenic bacteria are very small (1 micron × 2 microns), rod-shaped, unicellular organisms, which gain entrance into plant tissues through natural openings or wounds, the wounds made by insects being readily utilized. A large number of plant diseases are due to the activity of pathogenic bacteria, of which the most important in India are the ring disease of potatoes, canker of citrus trees and yellow rot of wheat ears. Fire blight of orchard fruits, bacterial wilt of cucurbits, bacterial soft rot of vegetables, bacterial wilt of corn are the more common bacterial diseases in foreign countries.

Bacteria cause three types of diseases in plants: (*i*) *Vascular Disease.*—Large number of bacteria clog the xylem vessels interfering with supply of water to foliage and the plants wilt, *e.g.*, bacterial wilt of tobacco; (*ii*) *Parenchyma Disease.*—The bacterium invades the soft and succulent tissues resulting in rotting, *e.g.*, soft rot of arrots or spotting leaves of cotton; (*iii*) *Tubercles, tumors or galls, e.g.*, crown gall of fruit trees.

Some insects aid in the spread and development of bacterial diseases. In 1891 Waite, an American worker, showed that honey bees, while visiting apple and pear blossoms in search of nectar, were active vectors of the bacteria causing fire blight of peas. This was the first report of an insect vector transmitting a bacterial disease of plants. What more, the beneficial honey bee, "one of man's best friends", whose importance in pollinating flowering plants and producing honey, was all too well known, was found guilty of transmitting a serious plant disease ! In later years similar records were made of insect-transmission of other important diseases like the destructive bacterial wilt of cucumber and muskmelons transmitted by the cucumber beetle, and the soft rot of vegeable crops carried by the seed corn maggot, and so on. It was also demonstrated that the bacteria depended on the insects both for survival over winter and for spread from plant to plant in summer. In some cases, a mutualistic symbiosis was observed, *e.g.*, the soft rot bacteria for the entry of which the insects make the necessary wounds in the vegetables, while the bacteria provide essential vitamins for the development of the fly maggots and also aid in the digestion of plant tissues.

Examples of Bacterial Diseases and Some of Their Insect Vectors

Bacterium and disease caused	Vector	Host plant	Remarks
Phytomonas citri (Hasse) (Citrus canker)	Insects, especially, leaf-miners	*Citrus*, *Jambhiri* *C. aurantium* and *C. aurantifolia*	Leaves, twigs, young branches and fruits most susceptible
Phytomonas solanaceaum (Smith) (Ring disease of potato)	Infection through the agency of insects does not take place in India	Potato ; also tomatoes, brinjal, tobacco, cotton, legumes, etc.	Common; plants suddenly wilt; tubers when cut show a brown ring near the edge containing bacteria. Disease both tuber borne and soil borne
P. tritici Huchinson (Yellowing rot of wheat ears)	Eelworms suspected vectors	Wheat	Curling of stalk and infloresence; spikelets turn bright yellow

INSECTS AND FUNGUS DISEASES

Fungi are minute plants consisting of a network of richly branched filaments—"hyphæ", and are characterised by two chief factors : (*i*) a complete lack of chlorophyll (the green colouring matter which enables higher plants to synthesize food in sunlight) and therefore with a saprophytic or parasitic mode of life ; and (*ii*) reproduction by spores. Fungi are responsible for many serious diseases of economic crops showing the familiar symptoms like rotting and damping off of seedlings, wilting, dwarfing and stunted growth of plants, leaf-spots, tar spots, shot-hole on leaves, canker, gummosis and exudations on stems, foot-rot and root-rot, destruction, suppression or alteration of the floral axis or flowers, witch's brooms, etc.

Ergot of rye and related cereals and grasses was the earliest fungus disease to be recognised as transmitted by insects. The fungus affects the young flowers and replaces the normal seed with a hard, black mass called a sclerotium. Certain flies are attracted to, and feed on, a sugary, foul-smelling fluid secreted by the fungus attacking the early blossoms, and in return transmit the spores of the fungus from flower to flower and enable the fungus to survive: an association for mutual benefit—*Mutualistic symbiosis.*

Stigmatomycosis is a plant injury caused by the feeding punctures of bugs. What was originally attributed to the toxic effect of the salivary secretions of the insects, is really caused by fungi introduced into plant tissues by insects while feeding. The role of fungi in stigmatomycosis was discovered in a study of the "cotton stainers" (*Dysdercus* spp.—Pyrrhocoridæ, Hemiptera). These bugs pierce the cotton bolls with their needle-like mouth parts for feeding and at the same time may carry from another infected plant an yeast-like fungus, which causes the staining of the cotton fibres, that ultimately become a worthless matted hard clump. A similar relationship exists between the green stink bug and the fungus that causes the destructive yeast spot on lima beans. The other important fungus diseases transmitted by insects are the fruit spoilage of figs due to internal rot, smut and souring diseases carried by the fig wasp, the dried fruit beetle and vinegar fly respectively, the Dutch elm disease and the blue stain of conifers transmitted entirely by the bark beetles, and the black stem rust of cereals transmitted by certain flies. In the last mentioned example, a symbiotic relationship exists between the flies and the fungus in that the flies feed on a sugary fragrant solution produced by the fungus and in return they are helpful in the sexual reproduction of the fungus as "pollinators" of spores.

Examples of Fungus Diseases and Some of Their Insect Vectors

Fungus (Pathogen) and disease caused	*Vector* (Insect)	Host plant	Remarks
Perennial canker	Wolly apple aphid, *Eriosoma lanigerum* (Hausman)(Aphididæ, Hemiptera)	Apple	Feeding of insect causes cracking of callus and permits entrance of pathogen.
Black mould (*Cephanodium* sp.)	Mango-hoppers *Idiocerus* spp.	Mango	
Black mould	Mealy bugs	*Glyricidea*	
Black mould of onion	Mites suspected vectors	Onion	

Mites distribute fig rust, and *Helopeltis* is associated with guava scab; further investigations are in progress.

CONTROL MEASURES

The common measures employed for the control of plant diseases caused by the viruses, bacteria, or fungi, include rotation of crops, rogueing, the removal of infected plants, use of virus-free seeds and resistant or immune varieties, use of effective fungicides against fungus diseases, heat treatments, etc. The logical method of control for insect-borne diseases is to control the insect vectors. DDT is the most useful of the new insecticides. It is effective against leaf-hoppers and it also destroys some of the important aphid vectors. Lindane, Parathion, Folidol, Methoxychlor and other new organic insecticides have also given promising results against most of the insect vectors. Systemic insecticides, like Pestox, Isopestox, Systox, etc., which invade entire plants, when applied on leaves or in soil, are toxic to aphids and may be useful in the control of the aphid-transmitted viruses of vegetable and garden plants.

USE OF TRAPS IN THE CONTROL OF INSECT PESTS

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THE use of traps in the control of insect pests may seem odd or out of date, particularly in view of the recent developments of certain potent insecticides which are being widely used in the control of insects in spite of many limitations. It need hardly be said that a suitable control measure is the one which is practicable under conditions existing here, cheap and effective. Traps, like many other mechanical and cultural methods of insect pest control will at once suggest themselves because of their simplicity, cheapness and ready availability of the materials required for traps.

The value of traps in reducing insect population is well known and in many cases trapping is an adjunct to other means of control, and in fact, for a few of the pests it is the only cheap and effective method of control.

A knowledge of the behaviour of the insect pest in its various stages of development is necessary while devising a trap, since advantage is taken of some dominating habit or fixed instinct in the insect species such as attraction to favoured food, plants, colours, odours and light. Most of the traps, therefore, combine means or materials that force or draw insects into a receptacle that prevents their escape or retains them long enough to permit destruction. Traps may be simple as boards on the ground near plants, a furrow around a field or a lantern over a tub of water. Or they may be mechanical devices, such as hopperdozers, hoppercatcher, aphiddozers, fly traps, moth traps, light traps, electric traps and others that have been successfully used for catching and killing a variety of insects.

LIGHT TRAPS

It is well known that light attracts several hundred kinds of night-flying insects including some of the serious crop pests, like the paddy stem-borer, the paddy gall-fly, the rice leaf-hopper, the groundnut *surul*, moths of some of the hairy caterpillars, cockchafar beetles, etc. A simple but effective light-trap, which can be devised by an average cultivator, may be made by having a bright lamp (hurricane lantern, or 'Petromax' or electric lamp) over a wide, shallow pan (earthen or tin) containing water with a small quantity of kerosene oil forming a thin film over the surface of water ; the insects as they are attracted strike against the lamp generally and drop down into the kerosened water and are entrapped and killed. Such traps are being used, with considerable success in the control of the above-mentioned pests, particularly the paddy stem-borer, and the groundnut *surul.*

Attraction of night-flying insects increases with an increase in intensity of light and ultra-violet. Blue and green lights generally have been shown to be more attractive than yellow, red or infra-red. Instead of the simple pan containing water, different kinds of contrivances such as a cone leading to a cyanide bottle and grid type or suction type electric traps have been evolved and are being used in other countries.

POISON BAITS

In the case of poison baits and bait traps, an attractant is used to lure insects into traps containing poisoned food. When used in traps, the attractant is frequently used alone, for example, to catch flying insects such as fruit flies, house flies, etc. Non-flying insects, such as grasshoppers, crickets, and larval forms especially cutworms, are killed with poison bait consisting of a carrier (bran, sawdust, chaff, etc.), an attractant (an odorous compound, such as amyl acetate, added to a palatable ingredient like molasses), and a poison (usually an arsenical). Other common examples of poison baits are the following ; ants may be trapped and killed in a can containing sugar solution *plus* sodium arsenate. House flies are attracted and killed in screened cage (with a cone) containing a poisoned bait of molasses and water (1 : 3 parts) *plus* some milk or fruit waste and nicotine sulphate. Sticky board or fly papers are also used against the house flies.

Sticky material coated on to cardboard, wire screening, etc., may also be used to trap some of the small flying insects, such as leaf-hoppers, psyllids, gall-gnats, etc. Sticky bands on the trunks of trees will prevent insects crawling up the plant. Different kinds of bands (cloth, corrugated paper, canvas, etc.) wound round the trunk of apple trees have been employed in various countries to trap larvæ of codling moth, which is a serious pest of apple.

Red cotton bugs are attracted in large numbers to muslin bags containing moistened cotton seeds and kept scattered in field.

In foreign countries also some success has been attained with the use of poison baits in the case of certain important crop pests, like the Japanese beetle, codling moth, oriental fruit moth, tobacco horn moth, fruit flies and mosquitoes. Fruit flies, in particular are trapped by using some protein material such as powdered egg albumen, dry yeast powder, or casein together with an alkali (sodium hydroxide). Lures composed of commercial ammonium sulphate are also attractive.

TRAP CROPS

Insects that feed on more than one crop may be trapped on one of them in order to protect another. For this reason trap crops have been recommended, the principle being that a small crop is grown in advance to attract most of the pest which is then destroyed before the main crop is sufficiently grown to be attacked by insects. In this method, destruction of trap-crop along with the insects in time before they get on to the main crop is all important, as otherwise the very purpose of laying out a trap-crop is defeated.

It is commonly seen that certain insect pests like the rice grasshopper and *jola* grasshopper congregate and feed gregariously in the patches of thick growth of the crops usually found here and there in places where manure was heaped for some time in fields before spreading it. This fact may be taken advantage of in the areas where these and other grasshoppers are serious pests, and narrow strips of densely grown crop may be provided round the plots which naturally attract the hoppers. These limited patches of the crop may be treated with a contact insecticide to kill the hoppers as they are attracted.

TRASH TRAPS

The habit of certain insects to hide under dry leaves, etc., in fields may be utilised in ragi, *jola* and sugarcane fields to trap the adults (moths) of stem-borers in heaps of trash placed here and there in the infested fields ; care should be taken to collect these moths every morning and destroy them or treat the heaps with some contact poison. Sugarcane termites may also be trapped in trash-heaps placed in furrows in termite infested fields and destroyed along with the termites periodically.

MISCELLANEOUS TRAPS

(*a*) *Grasshopper Bags, Hopperdozers, etc.*—These traps are mostly mechanical in nature and quite effective in reducing the pest population to considerable extent, if adopted in time. The *jola* grasshopper, sometimes a very serious pest on *jola,* and other grasshoppers may be trapped by drawing swiftly across the field a fairly big conical cloth bag, the wide mouth of which is fitted to a bamboo frame. This simple contrivance is quite suitable when the *jola* or other dry crop is young and this measure of control was extensively employed in Mysore State before the advent of BHC. Small insect collecting nets may also be employed in the collection of pests, like the rice grasshopper, the *jola* grasshopper, the rice bug, flea beetles, etc., especially when the area is small and in the early stages of the pest.

(*b*) *Trenches, etc.*—Crawling insects, especially those which move together in swarms from field to field, may be trapped and killed by providing trenches or barriers on their way. The most familiar examples of such insects are the army worms, hairy caterpillars and the locusts. For the army worms and hairy caterpillars steep-sided trenches are provided round the field or on their path. Providing long barriers in the form of metal sheets or bamboo matting on the ground in the path of locust bands, which usually move hopping in large numbers in their wingless younger stages, is the familiar method adopted in North India to prevent the spread of locusts from the breeding areas to other far off regions.

USING INSECTICIDES EFFECTIVELY

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In pest control operations the proper insecticide, proper application and proper timing are of equal importance. The best insecticide may fail in its action when used at the wrong time and in a wrong way. The use of excessive amount is also wasteful, expensive and many times injurious to the plants, animals or soil. Some knowledge about the habits of the pests we want to get rid of, the physical properties of insecticides we use and the influence of weather and the type of plant growth on their effectiveness, will greatly help to carry the operation efficiently.

Insecticides have been roughly grouped according to the way they get into the body cavity of the insect—stomach poisons, contact poisons and fumigants. Stomach poisons are eaten ; contact poisons enter through the skin and fumigants enter through the breathing organs or through the skin in gaseous form. Some insecticides may enter by all the three ways.

Contact insecticides are generally sprayed in the liquid form on the infested plants with the insects and usually used against sucking forms like plant lice, scales, mealy bugs, mealy wings, leaf-hoppers, etc. Thorough application is necessary in the case of contact insecticides. Because many of them may lose their toxicity in a short duration and the chance that the insects in moving about will come into contact with them later is not great. Pests like some aphids and scale insects, although they cannot move about and come into contact with the chemicals. are killed when the contact insecticide has fumigating action.

Thorough application of the stomach poisons is less necessary. They are used against biting insects like caterpillars, beetles, grasshoppers, etc. Caterpillars or larvæ move from leaf to leaf. Flying insects travel from plant to plant. An application that reaches only one surface of the foliage or reaches a part of the foliage may serve the purpose. Thorough application is however necessary to destroy a boring insect before it gets out of reach of the poison.

While using insecticides in the control of pests we have to consider the possible residual actions. Some insecticides, though effective, evaporate or decompose rapidly. Such chemicals are particularly useful in getting over a pest shortly before harvest as they do not leave harmful residues. If the period for control is long, frequent application of insecticide which rapidly decomposes may be necessary. On the other hand, a single application may be enough in the case of insecticide that retains its effectiveness for a long time.

The physical properties of insecticidal dusts such as particle size, bulk density and flowability are important. Dusts, carried to the plants by a stream of air, are easily drifted by wind currents. The adherence of the particles to the surface depends upon the velocity at which they strike the surface. Very small particles in dusts tend to drift with the air currents and lose their velocity soon after leaving the outlet of the duster. The average size of the particles in dusts may be far above that required for use in sprays. Particles more than 40 microns in diameter are not suitable as they will not adhere well to the foliage. Weight of uncompacted dust in pounds per cubic foot is 'bulk density'. The less the weight greater the tendency there will be for the dust to float or drift with the air currents. Weight is particularly important in aircraft application since the dust has to settle quickly to the ground to avoid excessive drift. Dusts in aircraft application should not be less than 40 lb. per cubic foot. For application by ground equipment, dusts that have a bulk density of 30 lb. per cubic foot may be enough. Addition of mineral oil at the rate of 1-2% by weight helps in reducing the drift of dusts and may increase adherence to plants. Dusts must be free-flowing and devoid of lumps. A dust that packs will not give a uniform rate of flow from the duster and the application will be uneven. Flowability depends upon the inert filler. Some free-flowing materials are too light and they are mixed with heavy diluents to get desired flowability.

Quick-breaking emulsions produce better spray deposits than more stable emulsions. If the oil droplets in an emulsion are very small, no separation will occur even after standing for hours. If the size of the oil droplets are large, the emulsion will not be stable and the oil tends to rise and float on the surface. For insecticidal use we require something in between. It is desirable to have an emulsion that is sufficiently stable to remain in suspension in the spray tank and supply line but unstable enough to break immediately after leaving the nozzle, or upon contact with the surface. Such an emulsion gives a much higher deposit of the oil than the more stable one.

Wettable powders are mixed with water before use to form a suspension. Larger particles do not adhere well to plant foliage and give less coverage as there are less number of them in a given quantity of suspension. The particles must be smaller in size to give maximum efficiency.

Proper timing in the application of insecticides is important. If they are applied too early they may lose their effect before the pest appears or before the pest is in susceptible condition. If they are applied too late the pest may have already caused sufficient damage.. It is not desirable to treat crops when they are in blossoms as the pollinators like bees may be killed and the yield of fruit or seed crops is seriously reduced. The blossoms themselves may be injured sometimes.

Information on wind, temperature and rainfall is especially useful when controlling insect pests. Spraying is interfered with if the wind is blowing more than 5 or 6 miles an hour. Application of dusts should be made in the early mornings or evenings. After the sun has warmed the air, rising currents tend to carry the dust away from the crop. Perfectly calm weather is not necessary for dusting and a slight drift may facilitate it. Most insecticides are effective at ordinary temperatures. There is danger of injury to fruit or foliage if some materials are used in hot weather. There is also danger of injury from oil sprays if followed by extremely cold weather. Rains may wash off insecticides that are soluble in water and their effectiveness is lost. Most of modern insecticides are not soluble in water and many of them adhere well to fruit and foliage. Their effectiveness is not much reduced by ordinary rainfall. Dusts are removed more extensively than sprays by rains. The presence of dew or moisture on plants is sometimes a help when dusting. It causes the dust to adhere better than if the surface is dry.

Consideration should be given to the condition of the plant itself. Fast-growing plants require more frequent applications of insecticides than that are growing slowly. Rough or hairy surfaces are more easily covered with either dusts or liquids. Any smooth or waxy leaf or fruit surface is not easily coated with insecticides. Very heavy foliage seriously interferes with getting an insecticide to the pests.

ORGANIC INSECTICIDES

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DURING recent years large number of organic compounds whose basis is carbon have been investigated as to their insecticidal value. Many of them are still in the experimental and developmental stages. Among these organic compounds are stomach poisons, contact posions, systemic insecticides, fumigants, repellents, attractants and synergists. The chemistry of wide variety of these synthetic organic compounds covers almost the entire field of organic chemistry. The following organic insecticides which are of importance and are in use in the control of various types of insect enemies have been mentioned.

Phenothiazine was introduced as an insecticide in the year 1935. This may be considered one of the early members of the newer synthetic organic compounds. It is a product of the reaction between diphenyl-amine and sulphur in the presence of iodine used as a catalyst. It is a stomach poison and is used extensively for the internal medication of livestock, for the control and removal of injurious nematodes that infest cattle, horses, sheep and goats. Considerable quantities of phenothiazine were used in combination with arsenate to control the codling moth in apple orchards of the Appalachian area. The relatively high cost and the fact that many men suffered dermatitis when mixing and applying the spray limited its use.

Azobenzene was found in 1943 to be effective as a fumigant for the control of mites. It is an orange crystalline material prepared by redusting nitrobenzene with iron in sodium hydroxide solution or by electrolytic reduction of nitrobenzene in dilute alkali. It is a contact insecticide and it is still being used experimentally for control of sucking insects.

A group of dinitro derivatives of phenol and cresol which are contact insecticides came into use before Second World War. A well known brand of the phenol type, dinitro-ortho-cyclo-hexyl-phenol, is called Dow Dormant. It is yellow in colour. Di-Nitrol, the trade name for one of the dinitro-ortho cresols, is a dry, yellow powder. It is manufactured from coal tar products. The dinitro cresol products contain 40% active ingredients and the rest is usually talc and wetting agent. They are used in combination with dormant oils to kill leaf-rollers, bud moth, etc.

Organic thiocyanates are used to increase the killing power of low concentrations of rotenone and pyrethrum. Aliphatic thiocyanates are powerful contact insecticides and are used in controlling various agricultural insect pests, insects attacking stored food products in dairies, mills, warehouses, etc., and are designed for the control of such insects as flies, mosquitoes, bed-bugs, cockroaches, moths, etc.

More synthetic organic compounds with outstanding insecticidal properties have been discovered during the period 1942-47 than in all the previous years. Among these are the chlorinated hydrocarbons. Important members of this group are DDT, TDE (also known as DDD) benzene hexachloride, chlorinated camphene, chlordane, Aldrin and Dieldrin. The technical grades of all these products are mixtures of two or more isomeric compounds, the insecticidal value of which varies with the product and the test insect.

The name DDT is formed from initials of the chemical name dichloro-diphenyl-trichloroethane. DDT is made by condensing mono-chlorobenzene acid. The technical grade is a white powder, practically odourless when pure, insoluble in water but soluble in varying degrees in alcohol, kerosene and other organic solvents. DDT breaks down in the presence of sunlight and alkaline compounds. There are four general types of DDT. These are ordinary solutions, DDT emulsions, DDT dusts and wettable DDT powder. Ordinary solutions are prepared by dissolving technical DDT in alcohol, kerosene, petroleum, oil, carbon tetrachloride, ether and in similar organic solvents. Owing to its nature DDT alone is not a practical insecticide but must be dissolved to produce a spray, milled with 1-3 parts of inert material to make a fine powder suitable for suspending in water, or mixed with a large proportion of ingredient such as prophyllite, talc, sulphur or other material and milled for applying as a dust. Fineness of the particle is the important factor for effectiveness and easy application of the insecticide. When properly used DDT insecticides are outstandingly efficacious in controlling a large number of destructive pests. There has been considerable apprehension that the use of DDT insecticides in agriculture might kill off the parasitic and predaceous insects which normally help to hold injurious species under check. Caution must be exercised in this regard, otherwise a treatment may do more harm than good.

TDE—Rhothane—is an example for dichloro-diphenyl-dichloroethane or DDD. This insecticide is available in a wettable powder containing 50% DDD and in a solution containing 25% DDD. In experimental tests Rhothane has given good control of tomato insects, cabbage worms, leaf-hoppers, flea beetles, aphis on peas, groundnut, *avare* (*Dolichos lab-lab*), brinjal and cowpea ; mealy bugs on brinjal and epilachna grubs on potato. This is said to be less toxic than DDT to warm-blooded animals.

Benzene hexachloride is a chlorinated hydrocarbon made by reacting chlorine with benzene in the presence of ultra-violet light. Technical BHC is made up of a mixture of isomers. It is established that the action of the compound is almost entirely due to the presence of the gamma isomer. The compound is known as Gammexane. On many tests it is lethal as a stomach poison, a contact agent or as a fumigant. It can be prepared into wettable powders, emulsions, oil solutions and aerosols. The compound has excellent chemical stability and stands exposure to light, hot water and concentrated nitric acid. Like DDT it is compatible with lime. Tests have shown that the dust gives good control of several of the more important cotton insects. Its weakness in the control of boll worms is agreed. It is highly toxic to grasshoppers.

Toxaphene is a chlorinated camphene obtained by reacting chlorine with camphene. Technical grade is a cream-coloured waxy solid with a mild odour ; very soluble in common organic solvents. In solid form it may be stored for at least a year without deterioration. Solutions also can be stored with proper care for an equal period of time. Toxaphene is toxic to household insect pests and it is phytotoxic to cucurbits.

Chlordane is a chlorinated hydrocarbon obtained by subjecting two compounds called hexachloro-cyclo-pentadiene and cyclopentadiene to a reaction and treating the resulting product with chlorine. It is a nearly odourless, viscous, amber-coloured liquid and is soluble in the common organic solvents. It decomposes in the presence of alkalies with a resulting loss of insecticidal toxicity. It is not soluble in water. It has contact, stomach poison and fumigant action. It shows promise for controlling many crops, forage, cotton and soil pests. It is safe for use on foliage including tomatoes and cucurbits. It does not seem to be effective against plant mites.

Aldrin is a white solid which is practically odourless at room temperature, but it has a pine-like odour when warm. Dieldrin is odourless. Aldrin is soluble in the common organic solvents whereas Dieldrin is moderately soluble in the same solvents. Neither is soluble in water. Aldrin and dieldrin are highly toxic. Their products and formulations must be handled with care. Under normal conditions Aldrin volatilizes within a week, but Dieldrin retains its residual effectiveness for long periods. Aldrin and Dieldrin are highly effective against soil insects.

A new field of organic phosphorous insecticides was opened up during the Second World War. The list includes HETP, TEPP, Parathion, Octamethyl pyrophosphate amide. Because of their extreme toxicity to warm-blooded animals, these potent insecticides may not be used to control insects affecting man and animals such as household pests and cattle and sheep pests. Their potential usefulness is great, because they are effective at extremely low dosages against a wide range of insect species, and when properly applied leave a negligible spray residue on an agricultural crop.

Hexaethyl tetraphosphate (HETP) was developed in Germany during World War II. It is an amber-coloured liquid. The technical product is a mixture of organic phosphates, the principal active ingredient being tetraethyl pyrophosphate. It is miscible with water, alcohol, chloroform, etc. At ordinary temperature it is a stable product in the absence of moisture. It hydrolyzes rapidly when water is added and loses its insecticidal value. When diluted for spraying it should be used within one or two hours. It is effective against aphids, mites, leaf-hoppers thrips and many caterpillars. It is highly toxic to warm-blooded animals and is rapidly absorbed through the skin. It should be handled with care.

Tetraethyl pyrophosphate or TEPP is similar in its physical and chemical properties to hexaethyl tetraphosphate (HETP). TEPP is said to be 3-5 times more toxic to warm-blooded animals and to insects than HETP. It has been used in sprays to control mites. Persons handling this material should avoid contact with the skin.

Parathion was prepared under the code name of E. 605. The compound is a deep brown to yellow liquid, the pure compound being yellow. It is soluble in water only to the extent of 20 parts per million and is practically insolube in kerosene. It may be dissolved in alcohols and other solvents. It is moderately volatile and after several days under normal atmospheric conditions the spray and dust deposit loses toxicity to insects. Alkaline mixtures containing lime, lime sulphur and bordeaux mixture destroy its insecticidal value. It is a remarkably effective insecticide to control many kinds of insects infesting various crops.

Octamethyl pyrophosphoramide acts as systemic insecticide. The cotton seedlings raised from the seeds soaked in a very dilute water solution of this chemical and then planted were found to be insecticidal to aphids.

Synthetic organic compounds have been used as fumigants for nearly a century. They include hydrocarbon derivatives that contain sulphur, oxygen, chlorine, bromine and nitrogen. Carbon disulphide was the pioneer. Ethylene oxide was proposed as a fumigant in 1928; chloropicrin is used as a fumigant for grain and soils. Naphthalene is one of the older organic insecticides. It is obtained by the destructive distillations of coal. It has a fumigating action and has been used to protect woollen cloth against cloth moths.

Many organic insecticides have been introduced as synergists to increase the toxicity and to extend the supply of scare insecticides such as pyrethrum.

IMPORTANT DISEASES OF CHIEF FOOD CROPS IN MYSORE

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THE losses caused to food crops in Mysore by diseases are considerable. They amount to several crores of rupees in the aggregate. It is estimated that 9 million tons of food crops are lost annually in India due to diseases and pests in the field and storage. It would be a great step towards self-sufficiency in foodgrains if even 50% of the estimated loss is eliminated by adopting ordinary precautionary measures against common diseases prevalent on the crops. Seed-borne fungus diseases of grains are a serious cause of food losses. But they can be effectively controlled by eliminating primary infection in the seed and by adopting certain preventive and precautionary measures in the field.

The ravages caused by a caterpillar to a leaf or the damages done by an insect to a plant are very conspicuous to an unaided eye. But the same eye cannot discern the minute plant pathogen or the microscopic spores of fungi or the virus infected saliva that an aphid injects into a plant which it infects. Diseases of plants remain mysterious until its causal agents are well understood. The control of plant diseases is more difficult than that of insect pests. No practicable, effective curative methods are yet known. Only preventive measures can be adopted. Some common diseases prevalent on important food crops in Mysore and their remedial measures are given below :

Paddy (*Oryza sativa* L.)

Paddy forms the chief wet land crop covering nearly 8,00,000 acres under different conditions of cultivation in Mysore. Four diseases are commonly observed on the crop. They are blast, brown leaf-spot and grain-spot, silver shoot disease and false smut. The first two diseases affect the leaf and straw. The worst effect is from blast disease. The other diseases cause little damage.

BLAST (*Piricularia oryzœ*)

The disease is called *Benkiroga* as it spreads rapidly in the field like wild fire destroying the leaves. It becomes serious in some years and causes much damage to the crop. The destructive effects of the fungus are noticed on young plants in the nursery. The infection is noticed in three forms on the leaves and leaf-sheaths, on the stalk of the earheads and on the grains. Small, pale, somewhat watery, oval spots appear on the leaves and leaf-sheaths. The spots increase in size, turn brown with ashy grey centres. They coalesce with one another involving the whole leaf. The infected leaves dry and shrivel. The infection spreads from the lower, old leaves to the young leaves. In a severely infected field the crop puts forth a blasted appearance. The infected plants sometimes revive, send up new shoots and continue growing.

The fungus infects sometimes the stalk of the earhead and causes a rot of about ½-¾" long in the neck whence the disease is known as *rotten neck*. The grains of the infected earheads are poorly formed. In severe cases of infection the heads break at the weakened neck region. Greyish spots are seen on infected earheads and grains. Severely infected grains show an ashy colour. The worst effects of the disease are seen on the head when the infection is early and the fungus is well established before the head emerges out. The grains are not properly formed and high percentage of chaff results. The blast affected earheads contain some grains while those infested with borers are converted completely into chaff.

The outbreak of the disease depends upon weather conditions and on a number of other factors. Excessive application of nitrogenous fertilizers favours the development of the disease. Infected straw and chaff spreads the disease to a great distance. Seeds from infected crop carry the infection to any distance. The spores of the fungus are easily conveyed by wind and rain. The fungus is supposed to have a number of physiological races. Each race becomes predominant in a particular locality and on a particular variety. Hence raising of disease-resistant varieties has become complicated. A variety of paddy resistant to the disease in one locality may not be resistant in other places. Destruction of infected stubble and trash by burning them in the field reduces the amount of infectious material and prevents a severe outbreak of the disease in the following season. Treatment of seed before sowing with Ceresan or Agrosan G.N. at the rate of five *tolas* for 30 *seers* of seed reduces the primary infection carried on the seed. The seeds may also be steeped in 0·1% Ceresan-wet solution for 30 minutes, dried and sown. Dusting the seedlings in the nursery with fine sulphur dust controls the secondary infection to a great extent. The spread of infection in the field may be controlled by removing all the severely infected leaves as soon as they are noticed. Spraying the crop in the field with 1% Bordeaux mixture or with proprietary copper fungicides like Perenox or Cupravit controls the disease.

BROWN LEAF-SPOT AND GRAIN SPOT (*Helminthosporium oryzæ*)

This disease is widely distributed. It is not so serious in Mysore as in other parts of the country. The fungus attacks all parts of the plant in all stages of development. The most characteristic symptom of the disease is the appearance of small brown to dark brown spots on the leaves, leaf-sheaths and on the glumes. The spots are smaller than those caused by *Piricularia oryzæ*. The spots on the leaves gradually increase in size, become irregular in shape and coalesce with one another. When the infection is severe the leaves gradually wither and dry up, presenting an yellowish appearance. The disease develops and spreads rapidly in the fields under favourable moist weather. The fungus also causes a blighting of the ears. In severe cases the grains do not develop well and become chaffy. Infection is both internally and externally seed-borne. Seed treatment with organic-mercury fungicides like Ceresan at the rate of 5 *tolas* of dust for 30 *seers* of seed or by immersing the seeds for 30 minutes in 0·1% solution of Ceresan-wet, controls the disease. Internal infection can be eliminated by treating the seeds with hot water at 54° C. for 10 minutes after a preliminary soaking of the seeds in cold water for about 24 hours. But the heat treatment has to be done with great care so as not to injure the germinability of the seeds.

KARIKADDY ROGA (*Ephelis oryzœ*)

The disease on account of its characteristic effect is known in different localities by different names such as *Mathapkaddi roga*, *Udubathi roga* and *Beppuhode*. The disease is noticed on the crop cultivated under tank as well as channel-fed areas both in the *malnad* and *maidan* parts. The damage caused to the crop is not serious.

Infection is noticed sporadically in the field. The disease is readily made out as soon as the earheads emerge. The infected head emerges from the sheath as a glistening, greenish, cylindrical rod and stands out at a later stage prominently as a rigid, black, simple spike amidst the drooping healthy loose panicles. The grains and the spikelets are glued to one another and all to the central rachis. The infected grain contains a mass of mycelium with spores embedded in the mucilage. No healthy grain is found in an infected earhead. Both early and late varieties, the summer as well as monsoon crops are affected. The disease spreads to new localities with the distribution of seeds from infected varieties.

The same fungus occurs on other grasses like *Isachne elegans, Eragrostis tenuifolia, Echinochloa crusgalli* and *Setaria italica* growing in the vicinity of rice fields. It is probable that the infection on these hosts serve as a source of inoculum for paddy.

All infected plants with earheads should be picked, collected and burnt to prevent further spread of infection. Seeds from infected fields should not be used for sowing. The spread of infection may be controlled to a great extent by disinfecting the seeds before sowing with Ceresan, Agrosan G.N. or Fermate at the rate of 5 *tolas* for 30 *seers* of seed. The seeds should be well dressed with the required quantity of the fungicide in a seed-dresser or in a small tin provided with air-tight lid.

FALSE SMUT OR GREEN SMUT (*Ustilaginoidea virens*)

The disease usually affects only a few grains in a head. It resembles smut but the fungus causing this disease belongs to the group of Ascomycetes and not to the group of true smuts. Hence the disease is called false smut. The fungus develops its fructifications in the ovary of individual grains, which are transformed into large, velvety green masses of more than twice the diameter of the normal grain. The glumės remain unaltered. The green colour is superficial. When an infected grain is cut across, it is seen that the greater part of the central portion is a compact white mass; bounding this is a narrow orange-yellow zone and superficially is a powdery dark green layer. This peculiar enlargement of the grains is due to the growth within them of the fungus. The dense central white portion consists of the hyphæ closely woven together forming a compact pseudoparenchymatous body known as a sclerotium. Superficially the hyphæ produce minute spores in large numbers. The spores germinate and form secondary conidia. The infection probably occurs at flowering time. The disease is not severe.

STEM ROT : SCLEROTIAL DISEASE (*Sclerotium oryzœ*)

This disease is prevalent in all the rice-growing areas. But it is easily overlooked due to the obscurity of its symptoms. Infection is noticed on mature plants. Slight discolouration is noticed at the base of the culms. On splitting open such culms numerous minute, round, black, shining bodies are found. These are the sclerotia of the fungus which remain dotted all over the inner surface of the hollow stem. The fungus sometimes attacks the node some distance up the stem and gradually weakens the host. The infected lower leaf-sheaths begin to rot and a considerable number of grains in the ears do not mature. The plants in the infected clumps put forth characteristic late green shoots at the base when the rest of the crop is ripening and turning yellow. The sclerotia of the fungus persist in the soil. They germinate under favourable conditions and attack the crop. Collection and destruction of all the infected straw and stubble reduces the incidence of infection in the field.

KEMBATHI ROGA (*Cladosporium oryzœ*)

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The disease is noticed generally in thickly broadcasted fields. The fungus is a half saprophyte and infects weak plants. Small, dot-like, black spots appear distributed on the leaves and leaf-sheaths. In severe cases of infection the earheads are suppressed in growth, dwarfed or twisted and the grains remain undeveloped and may become chaffy. The spores of the fungus contained in the spots are easily conveyed by the wind and spread the disease rapidly under favourable environmental conditions.

The spread of the disease can be controlled in severely infected area by adopting good agricultural practices by broadcasting thinly, or sowing in drills or by adopting transplantation and by the application of good dose of manure so as to increase the vigour of the plants.

SEEGADI SATTE (*Chara*)

This is an algal weed which appears in paddy fields at first as thin filmy strands in patches. It grows rapidly and covers the whole plot forming a sort of thick carpetted growth. The matty growth of the weed does not allow the crop to thrive well. The common practice followed by the cultivators in the infested area is to drain off the water completely from the fields and allow the plots to dry. Some remove the weed by means of a rake. These methods are not helpful in eradicating the weed completely. Flooding the infested plots with dilute copper sulphate solution at the rate of 1 lb. in 3,000 or 6,000 gallons of water and allowing the solution to act for 24-36 hours eradicates the weed completely.

The water is completely drained off first from the plot. The area of the plot and the amount of water to be let into it are taken into consideration in calculating the quantity of copper sulphate required for the treatment. The required quantity of copper sulphate is tied up in a piece of cloth and placed in two or three places in the wake of the water inlet at the bunds. The water is allowed to flow slowly over it so as to obtain a uniform spread of the solution all over the plot. When all the copper sulphate is dissolved and when the required stand of water is reached in the plot, all the inlets are closed and the solution is allowed to stand for 24-36 hours. The quantity of copper sulphate required for treating 1 acre varies with the nature of growth of the weed and the quantity of water allowed to stand in the plot during the treatment. The same solution after treating one plot may be used for another by draining it into a lower plot. If the infestation is thick and if fresh sproutings emerge after the treatment, a second treatment after a fortnight completely eradicates the weed.

Ragi (*Eleusine coracana* Gaertn)

Ragi which forms the chief dry crop and staple food of 80% of the population in Mysore is fortunately subject to very few diseases. It occupies an area of about 20,00,000 acres under cultivation in the State.

SEEDLING BLIGHT, LEAF BLIGHT AND FOOT ROT OF RAGI

(*Helminthosporium nodulosum*)

This is the commonest disease of the crop in Mysore. It is reported to be prevalent in the United States, Philippines and Uganda. The disease is noticed to be severe in years of excessive rainfall. It is noticed in the field on plants here and there and sometimes in patches confined to definite areas. The fungus is present on all parts of the plant, on the seed, roots, culms, leaves and earheads. Seeds which are heavily infected do not germinate. They turn black, become soft and rot in the soil. The fungus present on the seed or in the soil infects the germinating seeds and reduces the stand of the crop in the fields. It infects the roots and the young shoots. Seedlings are killed before they emerge out of the soil. Such of the seedlings that withstand the attack and come out of the soil become weak and stunted in growth. The infection extends to the culms and leaves. Numerous, small, rusty brown, oval or irregular spots appear on the culms, and the leaves. These spots run together in severe cases of infection. The spots are observed on both surfaces of the leaf. The virulence of the disease is markedly observed at the earhead stage. Irregular brownish blotches appear on the culms, leaf-sheaths, internodes, rachis, spikes and spikelets. These discoloured blotches or lesions become more marked, as the plant grows up. The infected earheads or portions of it put forth a dried appearance in contrast to healthy green spikelets. The fungus produces spores abundantly on the earheads. The grains in the infected portions do not develop well. The minute spores of the fungus are easily disseminated by wind and other agencies over wide areas. The healthy grains get mixed up with the infected grains during harvesting and threshing. The fungus lives also for a considerable period on dead or dried portions of the plant remaining in the field after harvest. The infection thus spreads through infected seed, stubble, and soil and becomes epiphytotic under favourable atmospheric conditions.

The disease is seed-borne. The infection spreads primarily from the infected seeds. It is effectively controlled by disinfecting the seeds with seed disinfectants like Ceresan, Agrosan G.N. or Fermate at the rate of 2½ *tolas* for 15 *seers* of seed. The seeds should be thoroughly dressed with the fungicide by rotating them for 10-15 minutes in a seed dresser or by shaking well in a closed tin so as to cover the seeds uniformly with the fungicide. The treatment does not in any way affect the germination of the seeds. On the other hand, it increases the germination and stimulates the growth of the seedlings. The secondary infection on the crop in the field is difficult to control. But it can be reduced to a very great extent by adopting sanitary measures and good agricultural practices.

BLAST (*Piricularia* sp.)

This disease is similar to blast or *benki roga* appearing on paddy. Infection is usually noticed on seedlings in seed-beds. It is severe on irrigated crop. The disease assumes an epiphytotic form in humid atmosphere. Characteristic oval or elongated brownish spots appear on the blades. The fungus infects also the rachis and the spikelets. In severe cases of infection a rotten neck is produced below the earhead. The infected grains do not develop well and put forth a blasted appearance.

All infected blades and severely affected seedlings should be pulled out and destroyed as soon as they are noticed so as to prevent further spread of infection. Dusting the seedlings in the nursery with fine sulphur dust keeps the disease under control. Infected seedlings should be discarded while transplanting.

SMUT (*Melanopsichium eleusinis*)

The smut disease of ragi popularly known as *Kadige roga* is noticed mostly on *Hain* ragi. Infection is observed on a few individual grains scattered here and there on the earhead. The loss due to the infection is not great. Only individual grains are converted into large, roundish sacs which contain minute dust-like spores of the fungus. The infection is local. The fungus is present only in the ovary and not in the whole plant. The spores germinate readily, are carried easily by wind and infect the emerging earheads in the field.

Since the infection is not carried in or on the seed any treatment of seed will be of no avail. All the smutted earheads should be removed as soon as they are observed, collected and destroyed to prevent further infection and spread of the disease in the field.

GREEN EAR DISEASE (*Sclerophthora* sp.)

It occurs sporadically in the field. It is observed on both *Kar* and *Hain* ragi. The infected earheads put forth a characteristic brush-like appearance as the floral parts are turned into green leafy structures. The infected plants remain stunted in growth. The internodes are shortened and the leaves become close together putting forth a bunchy appearance. The affected earheads do not set seed. The damage to the crop is not serious. The infected earheads should be removed and destroyed to prevent further spread of infection.

STEM ROT, ROOT ROT (*Sclerotium rolfsii*)

The infection is severe in irrigated fields. The fungus thrives well under moist conditions in the field. It infects the culm at the soil level. The dense white mycelium forms a web-like, fan-shaped growth at the collar region. This characteristic growth is made out if the leaf-sheaths are pulled out at the affected region. The fungus develops small, white, round bodies which later turn brown in colour and look like ragi grains. These are the vegetative resting bodies of the fungus known as sclerotia. These bodies which are produced in abundance, drop to the ground and serve the fungus to tide over unfavourable weather conditions. Thus the fungus infects the soil which infects the plant and spreads rapidly under moist conditions.

Severely infected plants should be pulled out and destroyed to check the spread of infection in the field. Infected portions in the field may be treated with Bordeaux mixture or disinfected lightly with sulphur dust. The disease can be kept under control by adopting clean cultivation and opening good drainage.

DETERIORATION OF *Hagev* RAGI (*Heterosporium* sp.)

Old ragi grains stored underground in *hagev* which are pits of varying sizes show the presence of a fungus *Heterosporium* sp. and a gram positive bacterium. The lower layers of such grains stored for a long time put forth a dark colour and musty odour probably caused by fermentation due to imperfect storage. There have been reports of persons suffering from intestinal disorders with purging and vomiting due to the consumption of such old ragi from *hagev*. Similar disorders have been reported of persons consuming old wheat flour.

MOSAIC (A VIRUS DISEASE)

This is a virus disease which occurs on several crops all over the world. The disease is similar to mosaic disease of sugarcane and *jola* which is transmitted by insects. The infection is noticed usually on *gidda*[1] ragi. In severe cases of infection, 10-30% of the plants are affected. The leaves put forth a mottling appearance. The pale patches appearing on the green leaves can be very well made out on newly opened young leaves. The patches are irregular, oval, run parallel to the midrib and vary in shape and size. The infected plants remain stunted in growth. Some plants turn yellow which may be due to abnormal soil conditions or excessive wet growing period. The affected plants sometimes recover at a later period of growth and put forth normal earheads. The disease is not seed-borne. Virus diseases as a class are difficult to control. Such class of diseases are transmitted by insects known as aphids. Infected plants should be pulled out and destroyed at an early stage of infection so as to prevent further spread of infection on the crop.

DISCOLOURATION OF BLADES (PHYSIOLOGICAL)

Some varieties of ragi show stunted growth and an abnormal discolouration. The leaves and stems of the violet glume types gradually turn deep red while those of the green glume types turn yellow. This is attributed to abnormal soil conditions being excessively wet during the early stage of the growth of the plant and defective drainage in the field. The damage due to these discolourations is not severe.

STRIGA (A FLOWERING SEMIPARASITE)

This is a flowering plant growing as a parasite on the roots of both dry and irrigated ragi. The parasite establishes its connection with the roots of ragi and draws water and mineral salts from the host. It produces minute seeds which are easily disseminated by wind. The seeds germinate along with the ragi seed in the infested fields. The parasite should be completely weeded out systematically before it flowers. Early sowing of ragi should be taken up so that the crop comes to harvest before the striga ripens its fruits. The weed should be ploughed in before it sets seeds immediately after harvest of the crop. Repeated applications of selective weed killers like Methaxone or Fernoxone eradicates the weed.

Jola (*Sorghum vulgare* Pers.)

The total extent under *jola* in Mysore is of the order of 8,71,000 acres. Among the dry crops it stands next to ragi in importance and forms the third staple cereal in the State. Among the following diseases prevalent on the crop, the grain smut causes the worst effect.

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[1] *Gidda* ragi (a variety of dwarf ragi).

GRAIN SMUT (*Sphacelotheca sorghi*)

This is the most widely prevalent and destructive disease of *jola*. It is popularly known as *Kadige roga*. It is caused by the fungus *Sphacelotheca sorghi* which affects the ovaries. The loss due to the infection is 20-25% of the crop. The disease can be made out only when the earheads develop. Individual grains here and there on the earhead are converted into elongated white bodies which later turn dirty grey in colour. These bodies are the sacs filled with black dusty powder which are the spores of the fungus. In severe cases of infection all or most of the grains in the earhead may be affected. The size and shape of the affected bodies replacing the grains vary according to varieties. The bodies burst open and the black spores are disseminated widely. The spores germinate readily under moist conditions. They are also capable of retaining their viability for 5-6 years. These spores contaminate the field as also the healthy grains in the earheads while harvesting the crop in the field and threshing of the grain in the threshing yard. The spores in the field and on the seed germinate along with the *jola* seeds and infect the *jola* seedlings. The infection takes place between the time of germination and the sprouting of the seedlings and cannot be made out until the plant develops earheads.

Since the spores of the fungus are carried externally on the seed the disease can be controlled effectively by treating the seed before sowing. The seeds may be dusted with fine sulphur of 200-300 mesh at the rate of 2-3 oz. for 60 lb. of seed or 2½-4 *tolas* dust for 12 *seers* of seed. The seeds should be thoroughly mixed for 10-15 minutes with the dust either in a seed dresser or in a tin provided with air-tight lid. Treatment of seeds tried recently at the Government Central Farm, Hebbal, and in the laboratory at Bangalore with new proprietary fungicides, *viz.*, Ceresan, Agrosan G.N., Arasan, Fermate at the rate of 0·2% by weight have given very promising results. The germination of the seeds will not be affected in any way by the treatment with the fungicides. The incidence of infection has been very markedly reduced. The cost of treatment is very negligible.

LOOSE SMUT (*Sphacelotheca cruenta*)

This smut is usually confused with the grain smut of *jola*. The life-history of the fungus is similar to that of grain smut. But the species of the fungus causing the disease is different. The infected ears are somewhat looser than the healthy ones. Infection is observed on all the spikelets. A few spikelets may also be transformed into leafy structures. The spore sacs are about ¾″ long. They burst more easily than in the grain smut. The spores get exposed before the earhead emerges out from the sheaths. They are not capable of living as long as those of the grain smut.

The treatment of the seed before sowing with sulphur dust, Ceresan, Agrosan G.N., Arasan or Fermate in the same way as for grain smut controls the disease effectively.

HEAD SMUT (*Sorosporium reilianum*)

= Sphacelotheca reiliana

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In this case the whole earhead is affected. The fungus *Sorosporium reilianum* affects the whole plant. A thin membrane covers the infected parts. The membrane ruptures and exposes the black spores in mass which are easily disseminated by wind and other agencies. The fungus sometimes infects also the leaves surrounding the smutted earheads. The spores shed in the soil from infected earheads do not germinate readily. They remain alive in the soil in the infected fields for a long time and infect the next crop when it is sown.

Treatment of seeds does not control this disease. All the infected plants should be removed completely as soon as the infection is noticed and before the spores are shed on the soil. *Jola* should not be cultivated for a few years in fields severely infected with the disease.

LONG SMUT (*Tolyposporium ehrenbergii*)

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This smut is luckily not so common here as it is in the neighbouring parts of the Madras State. Only a few grains in the earhead are attacked. The spore sac is about ½-1″ long and is curved. It breaks open at the tip exposing the spores which are carried by wind to the other earheads. Infection takes place on the young earheads in the field in the same way as in ragi smut.

The disease is not carried in or on the seed. So the treatment of seed will be of no use. All the smutted heads should be collected and destroyed. Seeds selected from fields which are free from infection should be used for sowing.

RUST (*Puccinia purpurea*)

This is a very common disease of *jola* caused by the fungus *Puccinia purpurea*. Numerous small, bright, purplish-red spots appear on the leaves. Infection usually takes place on grown-up crops and increases as the crop reaches maturity. Lower and older leaves of the plant are severely affected. Small brown or reddish pustules appear on the undersurface of the leaves. These are the *uredo sori* which are covered by the epidermis of the leaf. The epidermis ruptures exposing in abundance rusty brown uredospores which serve to spread the infection rapidly in the field. At a later stage reddish brown teleutospores also appear on the same spots. Cultivation of *jola* successively year after year in the same field keeps the fungus alive. In severe cases of infection rotation of crops should be practised. Varieties resistant to the disease should be cultivated.

RED LEAF SPOT (*Colletotrichum graminicolum*)

This disease caused by the fungus *Colletotrichum graminicolum* is more common than rust. Red spots appear on both the upper and lower surfaces of the leaves. The mature spots at a later stage of infection have a straw-coloured centre. Minute black dots appear at the centre of the spots. These black specks are the fruit bodies of the fungus. They contain numerous spores of the fungus and spread the infection.

The disease does not cause much damage to the crop. All severely infected leaves should be collected and destroyed at the early stage of the disease to minimize the foci of infection in the crop.

DOWNY MILDEW (*Sclerospora sorghi*)

The pathogen *Sclerospora sorghi* responsible for this disease is observed to infect the plants here and there in the field. The affected plants put forth pale yellow narrow leaves. The infected leaves are covered with a white ashy growth which is the conidial stage of the fungus. At a later stage leaves turn brown and characteristically shred into long thin strips. Numerous oospores develop in the infected tissue of leaf. The affected plants remain stunted in growth. The earheads remain small with a few small grains or may not develop at all. The disease is soil-borne and is systemic.

The loss due to the disease is not serious. All the infected plants should be pulled out at an early stage of infection and destroyed to minimize the foci of infection in the field. Resistant varieties should be cultivated.

JONI ROGA OR SUGARY DISEASE (*Sphacelia sorghi*)

This is known as *Joni roga* as the fungus *Sphacelia sorghi* produce in the infected earheads a sugary secretion. This secretion drips down on the leaves, dries up and forms a sort of whitish coating. This sugary secretion consists of the conidial stage of the fungus and attracts insects which thus play a great part in spreading the fungus. The disease is not serious and no remedial measure is necessary. In severe cases of infection the infected plants may be removed and destroyed to prevent further spread of the disease.

STRIGA (A FLOWERING SEMI-PARASITE)

This is a flowering semi-parasite growing on the roots of *jola*, ragi, *bajra*, paddy, sugarcane and other grasses. It establishes its connection with the roots of the host and draws its water and mineral salts from the host. The seeds of the parasite are very minute and are easily disseminated by wind. They readily germinate in the presence of the host plant but not otherwise. They germinate in the field, attack the roots of *jola* and thrive at the expense of hosts. In severely infested fields, rotation of crops which are not affected by striga should be adopted, trap crops should be raised and striga-resistant varieties should be cultivated

Spraying or dusting the infested field systematically with selective weed killers like "Fernoxone" or "Methoxone" eradicates the weed. These kill or severely depress the dicotyledonous plants (broad-leaved) and do not harm the monocotyledonous plants like cereals and grasses.

Wheat (*Triticum vulgare*)

Wheat is a minor crop in Mysore. Its cultivation is about an acre per thousand of the net cropped area of the State being mostly under irrigation from tanks or wells. It is also grown dry (rainfed) in the black cotton soil areas of Chickmagalur, Chitaldrug and Shimoga Districts.

RUST (*Puccinia graminis, Puccinia triticina* and *Puccinia glumarum*)

Of the three different forms of rust attacking wheat in India only black or stem rust caused by *Puccinia graminis* and brown (orange) or leaf-rust caused by *Puccinia triticina* are met with in Mysore. Severe losses are caused by the infection.

Black rust appears on the crop late in the season. Large, elongated, brown pustules appear prominently on the culms, leaf-sheaths and leaves. These pustules or *uredo sori* coalesce with one another and soon burst exposing a brown powder the uredospores. Each sorus contains hundreds of such uredospores. These spores germinate readily in moist air, and produce fresh infection and thus spread the disease rapidly in the field. At a later stage of infection a second type of spore the teliospores are produced in pustules chiefly on the leaf-sheaths and culms. These pustules are dark brown to black in colour and burst through the epidermis exposing a black bed of teleutospores. These spores have a long rest period. The fungus is segregated into several physiological races of which only four are known to exist in Mysore. These races differ in their ability to attack different varieties of wheat. A variety resistant to one race may not be so to another. Successful control of the disease depends upon the cultivation of the varieties that are resistant to majority of these races.

Brown rust is not so common in its occurrence as the black rust. Here the pustules appear in small clusters or irregularly scattered, usually on the leaves and scarcely on the leaf-sheaths and culms. They are never in rows or strips. They are round to slightly oblong and the uredospores are of a bright orange colour when fresh. Teleutospores are rarely met with. The disease persists in the uredial stage. As with black rust there are several physiological races existing in brown rust also of which four are so far known to exist in Mysore. Varieties of wheat that are resistant to these physiological races have been discovered and their cultivation would be very helpful in bringing the disease under control.

Dusting the crop with fine sulphur dust or spraying with sulphur products as soon as the infection is noticed controls the disease to some extent. But the best way is to grow disease-resistant varieties.

LOOSE SMUT (*Ustilago tritici*)

This disease is observed wherever wheat is cultivated. The infection is made out only when the plants come into ear. It does not affect the yield seriously. Th spikelets of infected earheads are converted into black powdery structures. The powdery mass of spores of the smut fungus is covered by a thin silvery membrane. The membrane ruptures and exposes the spores even before the head emerges out of the enclosed sheath. The infected spikelets are completely destroyed, the spores are blown away by the wind and the bare rachis stands behind. Infection takes place at the flowering time. The spores which are carried by wind and rain fall on the feathery stigmas and infect the developing ovules. The fungus remains in the grain in a dormant state as the seed matures. Infected seeds appear perfectly healthy. But when seeds are sown and begin to germinate the dormant mycelium within the seed grows also inside the growing shoot and keeps pace with the growth of the young seedlings. As the earhead develops, the fungus grows vigorously and destroys the structure of the flower.

The fungus that is carried within the seed in the form of a dormant mycelium can be destroyed by application of heat at a particular temperature. The seeds are given a preliminary soaking in cold water for 4-6 hours so as to induce the dormant mycelium to germinate. They are then quickly immersed in warm water at a temperature ranging from 124-30° F. for 10 minutes. One must be careful in adopting this method to see that the mycelium contained inside the seed is killed and that the treatment does not in any way injure the seed. Raising of immune or resistant varieties to the disease is the best method of controlling the disease.

Bajra (*Pennisetum typhoideum* Rich.)

GREEN EAR DISEASE OR DOWNY MILDEW (*Sclerospora graminicola*)

This is a common disease occurring sporadically on the plants in the field. It does not cause much damage to the crop. The solid spicate ears are transformed wholly or partly into a loose green head consisting of a mass of small twisted leaves giving the whole earhead a green appearance. Sometimes the leaves of infected plants show long whitish streaks which later turn to brown and tend to split into shreds. The disease is primarily a soil-borne disease. The oospores fallen to the ground with the infected plant germinate under favourable conditions of atmosphere and infect the seedlings. Secondary infection also takes place by means of zoospores which serve to spread the disease quickly. All the severely infected plants should be picked out and destroyed so as to prevent the spread of further infection in the field. Resistant varieties should be raised.

SMUT (*Tolyposporium penicillariœ*)

Infection is noticed only in scattered grains in the ear. The majority of the grains develop normally. The fungus infects the ovaries which are converted into oval or pear-shaped bodies or sori. These sori are usually twice the diameter of the normal grain. They are greenish at an early stage of infection and later turn black. These sori or bodies contain the spore balls of the fungus. The infection is air-borne. The spore balls fall to the ground, germinate and the spores that are formed are conveyed by wind to the flowers where immediate infection takes place. So seed treatment will not do any good in controlling air-borne smuts. All the smutted ears should be collected and destroyed so as to prevent further infection of the area.

Navane (*Setaria italica* Beauv)

GREEN EAR DISEASE (*Sclerospora graminicola*)

The symptoms of this disease are almost similar to those described under green ear disease of *bajra*. The shredding of the leaves is more marked here than on bajra. Healthy seeds selected from disease-free crop should be used and an infected field should not again be sown with setaria for 2-3 years.

RUST (*Uromyces setariæ italicæ*)

The disease is observed commonly wherever the crop is cultivated on a large scale. The infection is usually noticed on grown-up plants. Small, oblong cinnamon-brown pustules appear in rows on the leaves. The pustules burst and expose the uredospores contained within. The damage is serious when infection takes place on young plants. Resistant varieties should be cultivated.

SMUT (*Ustilago crameri*)

This is a common disease prevalent on the crop. The normal grains on the ear are replaced by large, round or pear-shaped, greenish white bodies which contain the black spore-powder of the fungus. The bodies or sori rupture and expose the spores which are disseminated by wind. Spores get mixed up with the grain and adhere to the seed-coat during threshing. Infection occurs in the seedling stage from spores adhering to the grain just in the same way as in grain smut of *jola*. Hence the treatment is on the same lines as for grain smut of *jola*.

SOME COMMON DISEASES OF FRUIT PLANTS IN MYSORE

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Mango (*Mangifera indica* L.)

Powdery Mildew (*Oidium mangiferæ*)

This is the most destructive disease of mango. It appears during the flowering season and reduces the crop considerably. A whitish or greyish powdery growth of the fungus appears on the young leaves, flowers and stalks. It causes brownish or darkish spots on the leaves. In severe cases of infection the leaves become distorted, the infected flowers and young tender fruits are shed. The fungus is a superficial parasite which spreads rapidly during cold season. The infection by the fungus coincides with the attack of mango hoppers on the inflorescences. A thorough dusting with fine sulphur or spraying with sulphur preparations done at the time of flowering and repeated again as the fresh flowering spikes appear at intervals of 15-20 days check the spread of the disease.

Bacterial Disease (*Pseudomonas mangifera indicæ*)

Numerous, small, angular, water-soaked spots appear on the leaves. The spots are at first yellowish. As the infection advances they turn dark brown with a halo around them. They coalesce with one another, form large necrotic areas with an exudation of bacterial gum. Severely infected leaves are deformed. The infection causes deep longitudinal cracks on tender stems, petioles and stalks of the fruit. Young heavily infected fruits drop to the ground. Water-soaked areas appear first on the fruits, the infection spreads and the spots later turn black. The deep longitudinal cracks appearing on the surface of the fruit are accompanied by heavy bacterial gummy exudations. Infected fruits are easily detached by the wind, fall to the ground and rot. The infection spreads through wind and rain. All the infected leaves and fruits should be collected and burnt to prevent further spread of infection.

Anthracnose (*Glœosporium mangiferæ*)

The fungus infects young twigs, leaves, flower stalks, flowers and fruits. Small, black spots appear on the tender twigs and leaves. The spots enlarge and turn dark brown on the leaves. Young leaves wither and dry up. The infected flowers turn black in moist weather and wither and young infected fruits are shed. The spots on old fruits develop and increase in size as the fruit matures. The fungus causes die-back when the infection is severe on the twigs and branches. The disease is controlled by spraying the plants thoroughly with 1% Bordeaux mixture and by repeating the treatment 2 or 3 times at intervals of 15-20 days. Care should be taken to see that no injury is caused to the fruits while picking and storing in order to prevent storage rot during storage.

SOOTY MOULD (*Capnodium ramosum, Meliola mangiferæ*)

The injury caused by the fungus is slight. The fungus makes a black, velvety, membranous growth on the leaves, twigs, and sometimes on fruits. The black covering is purely superficial. But it interferes with the photosynthetic activity of the leaf and thus indirectly affects the growth of the plants. The infection is chiefly due to the infestation of certain insects that exude a sugary secretion known as 'honey dew'. The fungus grows in these secretions and accompanies the insects. The fungus can be successfully eradicated by destroying the insects with suitable insecticides.

BLACK STEM (*Rhinocladium corticolum*)

A black felt-like coating of the fungus appears here and there on some of the branches and twigs. This is a very minor disease and does not cause much damage.

ROOT DISEASE

Plants in neglected groves and under unfavourable soil conditions sometimes wilt and die. The disease is serious in ill-drained patches. The affected trees suffer from severe crinkling of the edges of the leaves, from absence of new growth and gradual die-back. Various fungi, chiefly *Diplodia*, are found associated with the roots of such plants. The chief cause which in most of the cases is lack of good and proper drainage should be attended to followed with proper and good cultural practices.

RED RUST (*Cephaleuros virescens*)

This is an algal growth. It appears as round reddish patches on the leaves. The infection is noticed in areas where there is heavy rainfall. This does not cause much damage.

Bandarike (*Loranthus* sp.)

This is a parasitic flowering plant which grows commonly on mango trees in neglected groves. The parasite grows as bunched tufts of leafy perennial shoots on the branches of the tree. The parasite sends in its suckers into the branches. The stem of the parasite extends in the cortex of the host, forms an haustorium from which peg-like sinkers grow which penetrate to the cambium and later become embedded in the wood. The haustoria and sinkers fix the parasite on the host and serve as absorbing structures through which they absorb the food materials from the tree. The parasite produces viscid fruits which are picked up as food by birds which disperse them by wiping their beaks against branches of the trees. The viscid substance makes the seed stick to the branches where it germinates and spreads out to attack itself. The parasite should be removed completely along with the haustoria and sinkers and destroyed. In severe cases the branches on which the parasites grow should be pruned off some distance below the place of attack.

Plantain (*Musa sapientum* L.)

PSEUDOSTEM ROT, *Tharagumari Roga* (*Corticium rolfsii*)

The disease is noticed in patches on isolated plants in the garden. The plants are retarded in growth and put forth a sickly appearance. The fungus infects the pseudostem near the ground and extends upwards to a height of 3-4′. Large discoloured patches appear on the leaf-sheaths. The patches enlarge as the infection advances and assume a straw-coloured centre with a reddish brown margin. The infection extends from sheath to sheath inwards. This impairs the function of the sheaths and weakens their support to the pseudostem. The pseudostem sometimes splits longitudinally as in the wilt disease. The leaves lose their dark green colour, turn yellow, gradually droop and begin to dry one after another. The growth of the fungus is readily made out on the leaf-sheaths by the characteristic fan-like, luxurious growth of the white mycelium. Numerous, small, dark, round bodies develop on the web of mycelium. These are at first white and appear later like ragi grains. These are the sclerotia of the fungus. They are hard, durable bodies capable of living for 2 or 3 years and serve to reproduce the fungus. The fungus also develops minute spores known as basidiospores which serve to spread the infection rapidly in the garden whereas the sclerotia carry the infection from year to year tiding over unfavourable climatic conditions. The sclerotia which are produced in abundance, drop to the ground, germinate under favourable environmental conditions and infect healthy plants. Thus the infection in the soil or on the affected plants spreads the disease.

It is better to avoid cultivation of plantain for some years in gardens where the infection is severe. All the infected leaf-sheaths should be removed and destroyed before the sclerotia develop or shed. Healthy suckers selected from disease-free gardens should be used for planting. Bordeaux paste (1-2-1½) should be swabbed around the base of the pseudostem to a height of 2-3′ from the ground level. About 100 plants may be treated with 1 lb. of copper sulphate and 2 lb. of lime in 6 *seers* of water.

WILT; PANAMA DISEASE (*Fusarium oxysporum f. cubense*)

This is a destructive disease prevalent on all types of land. The disease is severe in waterlogged soils and spreads rapidly in wet weather. The outer or older leaves of the plant turn yellow from the margin, the leafstalks bend down and the leaves turn brown and dry up in succession. The last leaf often stands erect and green for a time before it falls. Finally the entire plant falls down and rots. Another characteristic symptom but not always is the longitudinal splitting of the outer leaf-sheaths at the base of the pseudostem just above the soil level. Infected plants rarely put forth the bunches. The fruits when produced show arrested development, remain small and do not ripen properly. In severely infected gardens the suckers are often dwarfed. When a rhizome of an infected plant is cut through transversely the vascular bundles, which in healthy plants is uniformly white, show discolouration with rows of yellow, orange, red or red-brown spots and streaks. These discolourations extend in advanced stages of infection to the tip of the rhizome and to the leaf-bases of the pseudostem.

The fungus lives in the soil and enters the plants through the roots or through the cut surfaces produced in the removal of suckers. The infection in the diseased clumps extends through the connecting vessels to the newly developed suckers. Distribution and propagation of such suckers spreads the disease. The spores of the fungus are conveyed by wind, by drainage water, and in soil adhering to implements and to the feet of labourers working in the garden and thus spread the disease.

The most successful form of control against Fusarium diseases is to raise immune or resistant varieties and to avoid contaminated soil. Suckers for planting should be selected from healthy plants in disease-free gardens. All suckers that show discoloured spots or streaks should be rejected. All infected clumps should be dug up completely with roots and rhizomes and the whole plant with the leaves, pseudostem, rhizome and roots should be destroyed to prevent further spread of infection.

BLACK HEAD DISEASE (*Ceratostomella paradoxa—Thielaviopsis paradoxa*)

This name is applied to any disease of the bulb or rhizome, showing superficial or internal, brown or dark water-soaked patches. The bunches produced by infected plants remain small. The smoky coloured hyphæ of the fungus rapidly invade the tissues of the wounded suckers and produce a rusty discolouration. The tissues, though water-soaked, remain firm and united. The infection spreads through the soil and wind. The cut surfaces of the suckers or any wound exposes them readily to infection. Suckers from infected stools should not be used for planting. Infected clumps should be removed completely and destroyed. The cut surface of suckers should be protected by dipping in 2% Bordeaux mixture as soon as they are severed from the clumps.

Orange (*Citrus aurantium* L.)

POWDERY MILDEW (*Oidium*)

This is a common disease which is readily made out on orange plants. Small isolated spots appear on young leaves and shoots. The infected portions put forth the characteristic powdery appearance as if sprinkled with white flour. The white patches appear usually on the upper surface of the leaf. In severe cases of infection, the leaves show a marked crinkling. Young leaves shrivel and drop down leaving the twigs bare. The fungus is a superficial parasite and draws its nourishment by sending its haustoria into the epidermal cells of the host. The infection is carried by wind and spreads rapidly under warm moist conditions. Th disease is effectively controlled by dusting with fine sulphur, 2 or 3 times during the growing period. The dead and dying twigs may be pruned off and burnt. Sulphur preparations may also be sprayed to control the disease.

FRUIT ROT OR KOLEROGA (*Phytophthora* sp.)

This disease is noticed during the south-west monsoon. The fruits rot and drop down in great numbers. The fungus grows and spreads rapidly during moist warm weather. The disease can be controlled by spraying the plants thoroughly with 1% Bordeaux mixture.

GUMMOSIS, FOOT ROT (*Phytophthora* Sp.)

The fungus flourishes in moist situations and is common in heavy soils and in ill-drained gardens. The first indication of the disease is an exudation of gum from the bark of the trunk near the collar. The tissues of the collar beneath the bark are killed and the infection may spread upwards and downwards and extend to the main lateral roots. The bark cracks, dries up and falls off exposing the wood. Secondary infection by other organisms may cause a decay of the wood itself. In severe cases of infection the tree dies. Treatment should be taken in time. The diseased tissues should be scraped away as soon as noticed and the exposed portions should be painted with Bordeaux paste to prevent reinfection. Trees completely affected should be pulled out and destroyed. Plants grafted to resistant stock like sour orange may be cultivated.

CHLOROSIS OR MOTTLE LEAF

This disease is attributed to several causes. The trees show various kinds of yellowing of the leaves, which may be due to poor soils, extreme dry weather, lack of nitrogen, shortage of lime or other mineral elements. Chlorosis or mottle leaf or foliocellosis in which irregular spots occur between the lateral veins is met with in several gardens. A few leaves or branches may be affected or all the leaves in a tree may be involved. The leaves show chlorotic areas, irregular in outline situated between the main lateral veins on each side of the midrib. The midrib and secondary veins remain green resulting in irregular spotting or mottling of the leaves. In severe cases of infection the leaves do not develop to their normal size. The fruits remain small and the yield is considerably reduced. The trees may cease to bear fruit. The whole tree may become densely branched or stunted in growth and the twigs die back from the tips. In cases where iron is deficient, injection with iron salts or spraying with ferrous sulphate is beneficial. Deficiency of zinc is responsible in many cases. This is corrected by spraying with zinc sulphate. One pound of zinc sulphate is dissolved in 3 gallons of water. Two-fifths pound of lime is slaked with a little water at first and then made up to 7 gallons. The zinc sulphate solution is poured into lime solution and stirred. The spraying is best done when there is a new flush of leaves. Zinc sulphate may also be added at the rate of 20-25 lb. per tree to the soil. Chlorosis in some cases is due to the lack of carbohydrates in the leaves. Application of green manure in large doses and a good general manure restore the green colour of the leaves.

ANTHRACNOSE OR WITHER TIP (*Colletotrichum glœosporioides*)

This disease occurs on plants weakened by some other diseases, by unfavourable soil conditions or in neglected orchards. The leaves fall off from the small twigs. The tips of the twigs gradually die and turn a silvery, greyish colour. The acervuli of the fungus appear as small black dots on the dead twigs. The leaves may also be infected before they drop with light green spots which soon turn brown. The fungus also attacks the stem end of the young fruits causing them to fall. In severe cases the branches die back to such an extent that within a few years the tree dies. Pruning off and burning of all diseased twigs followed by good orchard practice with proper cultural methods controls the disease. Good control is secured by spraying the plants with 1% Bordeaux mixture.

Die-back is perhaps a debility disease. It is not so much a disease as a group of symptoms which vary somewhat under different conditions. In general the leaves turn yellow and fall and the shoot dies. The yield is greatly reduced. The larger branches also die and the tree succumbs in the course of a few years. The disease is severe in poorly drained soils. Insufficient organic matter in the soil, heavy manuring and heavy irrigation are some of the factors that contribute to disease conditions. Application of nitrogenous manures with good drainage controls the disease.

Die-back associated with *Diplodia* sp., pink disease due to *Corticium salmonicolor* and sooty mould following an infestation by scale insects are other diseases prevalent on citrus plants.

Sour lime (*Citrus medica* var. *acida*)

CITRUS CANKER (*Xanthomonas citri*)

This is one of the most prevalent diseases on citrus plants. It is caused by a bacteria. Cankers appear as small yellowish spots on the leaves, twigs, thorns and fruits. The spots enlarge, develop into lesions, become raised into a convex surface and turn brown in colour. As the disease advances the spots become corky and hard and rupture exposing a light brown, spongy central crater-like mass. The spots are usually surrounded by a characteristic halo, The crater-like appearance is very marked on fruits and twigs. Infection spreads by wind, rain and insects. The infection can be greatly reduced by collecting all the infected leaves as they fall on the ground and by pruning out all the diseased branches and twigs and destroying them. Infection is largely prevented by keeping the leaves and fruits thoroughly protected with lime sulphur solution. Resistant varieties may be cultivated in areas where the infection is severe.

Guava (*Psidium guajava* L.)

FRUIT SCAB—A CANKEROUS DISEASE (*Pestalotiopsis psidii* and *Glomerella psidii*)

This is a serious disease occurring on several local and grafted varieties of guava. Characteristic cankerous spots develop on young green as well as mature fruits. The spots develop in great numbers, enlarge, unite with one another and the fruit breaks open to expose the seeds. The infected fruits in severe cases remain undeveloped, become hard, malformed, mummified and drop down in great numbers. The two fungi associated with the disease are weak parasites which readily infect the injured fruits and leaves. The infection in the orchard probably follows the preliminary punctures that are caused by the insect *Helopeltis antonii* which are largely met with in guava gardens. All the infected fruits, leaves, mummies, dried and dropped fruits should be collected and destroyed.

Two or three thorough sprayings with lime sulphur solution (1 : 25) given at intervals of a fortnight at an early stage of infection controls the spread of the disease.

Pomegranate (*Punica granatum* L.)

FRUIT ROT (*Phomopsis* sp.)

The fungus is a weak parasite which attacks plants in crowded and neglected orchards. Brown or orange black, round pustules appear in patches on the surface of the fruits. The discolouration extends to the inner tissue and seeds. The fruits do not ripen well. The seeds remain immature. Young fruits rot when infection is severe. The whole fruit dries up and shallow depressions appear on the discoloured regions. Infected flowers drop down. The fungus which is capable of leading also a saprophytic life, survives on dried up twigs and branches of the tree and infects the succeeding crop of fruits and flowers. All the dried up twigs and branches, infected fruits and flowers should be completely removed and destroyed and the plants given a thorough spraying with 1% Bordeaux mixture.

Leaf and fruit spots are also caused by species of *Cercospora* and *Glœsporium* which may be controlled by spraying with Bordeaux mixture.

Papaya (*Carica papaya* L.)

STEM ROT, FOOT ROT OR COLLAR ROT (*Pythium* sp.)

This is a fairly common disease on papaya. Water-soaked patches appear on the stem near the ground. The patches become soft and extend upwards up to a height of 5-6′ on the stem. The bark begins to crack and a foul-smelling liquid oozes out, the tissue breaks down and the plant collapses. Infection spreads rapidly during the rainy season. Pythium is a soil-dwelling fungus and good drainage helps in avoiding the disease. Severely infected plants should be completely removed and destroyed. If the disease on the plants is noticed at an early stage of infection, the infected portions may be cut out and the cut surface painted with an antiseptic solution such as 50% solution of crude carbolic solution and then protected with coal-tar.

ANTHRACNOSE (*Glœosporium* Sp.)

Light yellow patches appear on the sides of the fruit exposed to the sun. The infected patches soften, turn brown and extend in area. Black dots which are the acervuli of the fungus appear later in concentric rings. The infection can be controlled by giving a good spraying with 1% Bordeaux mixture after picking out all the infected fruits.

Apple (*Pyrus malus* L.)

ROOT ROT (*Sclerotium rolfsii*)

This is the most serious of all the diseases affecting apple plants. The infected plants wilt as if suffering from drought. The fungus infects the main and side roots which dry up and are subsequently destroyed by white-ants. The roots show in the early stage of infection a whitish fan-like growth of the fungus which grows rapidly and produces small, round bodies. These are specialised masses of the fungus threads called sclerotia. They are whitish at first, turn later into dirty brown colour and look like ragi grains. They are the resting vegetative stages of the fungus which are capable of reproducing the disease. They develop in great numbers, drop to the ground and remain alive in the soil for more than 2 years and thus aid in spreading the disease. The severely infected plants should be pulled out, all the infected roots with sclerotia on them should be collected and destroyed so as to prevent further spread of the disease in the orchard. The roots of the remaining plants may be exposed as far as possible and sprayed with 1% Bordeaux mixture.

WOOD ROT, STEM ROT OR HEART ROT (*Schizophyllum* Sp.)

The fungus is a wound parasite which infects the plants through wounds in the bark, through broken twigs and stumps of the stock remaining after budding or through injuries by tools during cultivation. The twigs of the infected plants die. Canker or open wounds accompanied sometimes with a dark exudation appear on the main stem and branches. The rest of the bark remains healthy. The heart wood in the affected branches shows a brownish discolouration. The plants gradually succumb to infection.

In order to prevent the infection by this and other similar wound fungi great care should be taken to protect all the wounds after picking or pruning with white lead paint or other wound dressings. The cracks on the main stem caused by the intense heat of the western sun may be prevented by white washing the stems 2 or 3 times before and during the summer season.

POWDERY MILDEW (*Podosphœra leucotricha*)

This is a common disease prevalent on young shoots and leaves. The disease spreads rapidly during cloudy weather and in moist situations. The surface of the leaves are more or less covered. with the characteristic white or greyish powdery growth of the fungus. In severe cases of infection the young shoots are stunted in growth, the internodes are shortened, the leaves are reduced in size and curled. The fungus is supposed to live as a dormant mycelium in the buds and to resume its activity when the buds open and infect the new leaves and shoot. The disease can be easily controlled by spraying the plants with 1% Bordeaux mixture.

Grape (*Vitis vinifera* L.)

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avail

POWDERY MILDEW (*Uncinula necator*)

The disease affects all green parts of the plant. The fungus is a superficial parasite. White patches appear on the leaves and on the young shoots. The affected parts appear as if dusted with some white powder. The affected leaf is retarded in growth and becomes distorted. The infected flowers fail to set fruit. Infected young shoots remain stunted in growth. Fruits attacked when young fall off ; when half-grown they may be irregular in shape, become hardened and the surface becomes rough and discoloured. They may even crack or split when moulds and other saprophytic fungi invade. The ripe berries are not affected. The disease spreads rapidly in cloudy humid weather. Dusting the plants with fine sulphur with a duster or spraying with proprietary preparations of sulphur controls the disease effectively. Three dustings are necessary, the first when the shoots are 6-8" long, the second during or just before blossoming and the third 40-50 days later. The sulphur may be diluted up to 20% with some inert powder and this will not in any way affect the efficiency of sulphur. The total quantity of sulphur required for all three applications will be about 80-90 lb. per acre containing vines of average size. Spraying with Solbar also controls the disease.

DOWNY MILDEW (*Plasmopara viticola*)

The disease is noticed in wet weather during the rains of the north-east monsoon. The fungus attacks all green parts of the plant. Pale yellow spots appear on the upper surface of the leaf. These spots are of varying size and shape and appear transparent when held up against light. A white glistening growth appears immediately opposite these spots on the under-surface of the leaf. This velvety growth looks like 'down' on the chicken and hence the name the "downy mildew" as opposed to the "powdery mildew". As the spots grow older, the spots assume a grey or frosted appearance and the colour of the spots on the upper surface changes from yellow to brown and the affected tissues are killed. The green shoots, leaf-stalks and tendrils are also infected putting forth the same characteristic appearance. Affected shoots tend to become dwarfed or deformed and the leaves remain small. In severe cases of infection the shoots die and the leaves are shed. Affected fruits shrivel, become wrinkled, mummified, or rot and drop down. All old and fallen leaves and debris should be ploughed under or burnt. The vines should be sprayed early with 1% Bordeaux mixture or with Cupravit solution. Three sprayings may be necessary, the first to be done when the shoots are 6-8" long, the second just after blossoming and the third before the fruit changes colour. Spraying the crop will pay in the shape of increased yield and greater vigour of the plant. The number of treatments to be given depends upon the climatic conditions prevalent, the virulence of the disease and the susceptibility of the vines to the infection.

Elsinoe ampelina

ANTHRACNOSE—BIRD'S EYE SPOT (*Glœosporium ampelophagum*)

The disease flourishes in wet weather. It causes cankers on the leaves and shoots, prevents the setting of fruit and produces on the fruits circular red spots with grey centres and a dark brown margin called "bird's eye spots". Numerous, small dark brown or black spots which soon become sunken in the centre appear on the leaves, stems and fruits. The spots enlarge rapidly as the infected parts grow. The affected parts are distorted and stunted in growth. The spots may develop into open black scars or cankers and extend from the bark deep into the wood rendering the shoot weak and brittle. The flowers and fruits are destroyed on the affected bunches leaving the blackened and withered fruitstalks alone to remain behind. Spraying with Bordeaux mixture or Cupravit checks the disease. All diseased wood and leaves should be cut, collected and burnt. The first spraying should be given at the time of the bursting of the buds and then repeated at frequent intervals of 15-20 days.

RUST [*Physopella* (*Phakopsora*) *vitis*]

The infected leaves appear as if dusted with some yellow powder on the undersurface. The disease is locally known as *Arasinada roga* after its symptom. The fungus causes numerous minute spots on the undersurface of the leaf which are later covered by an orange yellow powder which are the urediospores of the fungus. The injected leaves dry up and drop down. The bearing wood is affected. The heavy defoliation affects the yield seriously. Dusting with fine sulphur or spraying with Solbar controls the disease. The number of applications depends upon the virulence of the disease, the climate and the susceptibility of the vines to the infection, etc. Some varieties are resistant to the disease.

Fig (*Ficus carica* L.)

RUST (*Cerotelium fici*) ..

This is a common disease prevalent on fig plants. It does considerable damage to the fig crop. Small, rusty spots appear on the lower surface of the leaf. The spots later turn brown in colour. Infected leaves fall prematurely which affects the vigour of the plant and consequently the yield of fruits. The severely infected leaves should be picked and destroyed and the plants repeatedly dusted with fine sulphur or by sulphur preparations.

Pine apple (*Ananas sativus* Schult L.)

ROT—KOLEROGA (*Phytophthora* sp.)

There are no serious diseases on pine apple. Young plants are sometimes affected by a rot of the leaf-bases. The fungus extends to the fruit and causes rotting of the tissues. Secondary organisms invade and complete the destruction. All the diseased plants should be pulled out as soon as they are noticed and the plants should be thoroughly sprayed with 1% Bordeaux mixture.

Jack (*Artocarpus integrifolia* L.)

SOFT ROT (*Rhizopus artocarpi*)

This is a common disease prevalent on the inflorescences of jack plant. The fungus attacks mostly the young male inflorescences. Sometimes the female inflorescences are also affected. The fungus makes a black dense growth on the inflorescences. The affected inflorescences decay and drop in great numbers. All the diseased inflorescences should be collected and destroyed. Repeated sprayings with 1% Bordeaux mixture given at frequent intervals controls the disease.

Watermelon (*Citrullus vulgaris* Schrad.)

DOWNY MILDEW (*Pseudoperonospora cubensis*)

This is a new disease occurring in Mysore. It attacks various cultivated cucurbits including watermelon and cantaloupe. The disease is of late spreading in Mysore. It appears on plants of all ages and reduces the yield of the crop. It becomes most destructive during the picking season. The fungus attacks the leaves. Yellowish, angular spots of varying sizes appear on the upper surface of the leaf. The spots enlarge, increase in number and become black, the infected tissue is killed, the leaves turn pale, become sickly and dry up. Infection extends to the young leaf and spreads rapidly in the field in warm wet weather. Spores of the fungus are produced in abundance on the lower surface of the yellow spots. The spores are conveyed by wind from plant to plant, germinate on the leaves under moist conditions and produce fresh infection. Spraying the vines with 1% Bordeaux mixture or 0·3% Cupravit or Dithane Z-78 solution controls the disease. The application of the mixture should be thorough so as to cover the undersurface of the leaves and should be at frequent intervals so as to cover all the fresh leaves of the vines.

The same disease is noticed also on sweet melon (*Cucumis melo*). The controlling measures are the same as for watermelons.

BUFFALO AS A DAIRY ANIMAL IN INDIA

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Introduction

The buffalo holds an unique position in India, of all the countries of the world, as a milch animal. There is no denying the fact that it plays a very important part in the agricultural economics of the country to-day, both in rural as well as urban areas. There is a great deal of controversy as to the wisdom of maintaining the buffalo by the cultivator as going against the interest of the cow, but it is not the intention in this article to go into this matter, as its main object is to deal with some of the important practical aspects of husbanding this animal from the point of view of dairying.

2. To-day some people talk with pride of India possessing one-third of the bovine population of the world, but whether that is a blessing or curse in relation to the available fodder and other requirements for the welfare of the cattle and the country's potential, history alone will prove it. There is no doubt, however, that the buffalo contributes a goodly proportion to the cattle wealth of the country. Buffaloes form 22·4% of the total cattle population of India. Their milk forms 54·4% of the total quantity of milk produced in the country, and more than 44% of this milk goes to provide *ghee,* which together with its bye-products forms the main source of animal fat for the overwhelming vegetarian population of the country. Unlike the arm-chair politician, to the cultivator, the buffalo is not an object of sentiment, but an economic necessity, and it is for this reason the whole picture of the cattle population in rural India has changed over, during the last decade or two. from one of majority of cows to buffaloes to-day, in spite of there being no large-scale organised effort being made by Government Departments to improve the buffalo. This is no doubt a matter of alarm to the protagonists of the cow, which is considered by them to be all-in-all for the country. Some of the main reasons why the buffalo finds favour with the average cultivator are as follows :

(*a*) As more and more land came under the plough, the natural grazing areas began to shrink, and this prevented the cattle owners from keeping cows, which as a rule were maintained in the past, primarily for bullock production and which required large areas to roam about. Under the circumstances, the buffalo which always formed the milch animal for the cultivator came into ascendency. It required comparatively small areas to roam about and caused less damage to neighbours' crops. In other words, the buffalo is a much more tractable animal and can be looked after more easily while out grazing, even by the youngest members of the farmer's family, which, to him, is a great advantage. Moreover, the buffalo is more suited to "stall-feeding" than an average Indian cow.

(*b*) Taking an average cow, an average buffalo is a better milk-yielder. Bigger returns in cash through the buffalo is of great consideration with the cultivator in his present poverty-stricken condition. Besides, the general standard of quality of the buffalo as a class, even to-day, is much higher than that of the cow, so it is easier for the farmer to obtain a good and economic milk producer in the buffalo than in the cow, in the market. As to how the buffalo gained ascendency over the cow in the matter of larger milk production, is wrapped up in past history, but a plausible explanation is that the cow has always been looked upon as the mother of the bullock and was bred as such.

(*c*) One of the main reasons for the buffalo finding favour with the cultivator is that it accepts much more readily than the cow, the coarse fodders and crop residues available with him, and converts them into a valuable food for human beings—milk. This is a consideration of great economic importance with the farmer, when he is to count every pie that he can get from the produce of his land.

(*d*) If, for no other reason, the buffalo can justify its importance in rural economy ; as a fat-producer it has no rival in the country, given average village conditions. This fat is readily converted into *ghee,* which is the only form in which the poor cultivator can conserve it in a marketable form as a product of milk, handicapped as he is to-day by distant markets, poor means of transport, adverse climate conditions, etc., etc.

(*e*) As the time of calvings and periods of lactations of cows and buffaloes differ from one another under ordinary village conditions, the buffalo helps in keeping up more or less a uniform supply of milk to its owner all throughout the year, where there is a mixed herd of cows and buffaloes. This is of great economic importance to the cattle owner, when he is in a position to find a ready market for his milk when situated nearby some urban area.

(*f*) There is no religious sentiment attached to the buffalo as to the cow—at least not to the same extent ; the owner, therefore, feels little compunction in getting rid of his unwanted animal. This is of great consideration with the cattle owner to-day when the country possesses cattle far in excess of its carrying capacity and there is such keen struggle for existence between human beings and cattle, due to shortage of cultivable land.

3. The buffalo is essentially a water-loving animal and should ordinarily be expected to thrive in marshy and humid areas. They are, however, found spread throughout the length and breadth of India. Strange to say, some of the best milch breeds in the country are to be found in the northern parts of India. How this came about is difficult to explain. Apart from the better performance at the pail, the northern breeds of buffaloes have better conformation and quality of make than those found in the south, the latter resembling the original jungle stock, from which the domestic buffalo was derived, than the former. Another interesting differing feature between the animals of the two parts of the country is their horns. The horns of the buffalo of the south are straight and long, resembling more the wild type, while that of the north are positively short and pronouncedly curved, so much so that the famous Murrah breed of the Rohtak and Karnal Districts of the Punjab, derives its name from the shape of its horns, which runs into spirals, the word *murr* meaning 'curl'. Although originally an animal of the marshy areas, prevailing in the peninsular part of the country, the buffalo is found to thrive the best in light sandy areas, with extremes of cold and heat, as are to be found in the north. The home of some of the well-known breeds like Nilli and Ravi are located in the riverain tracts in the tributaries of the Punjab rivers. Although water and wallowing are indispensable for its healthy existence, dry climate seems to suit it best. The better bred animals do not thrive in humid climate. In performance also they definitely go down when brought down from north to south. A striking example of it was provided when a well-bred herd of Murrah buffaloes was brought down from the Government Cattle Breeding Farm at Karnal (Punjab) to the Dairy Institute, Bangalore, when the performance of the herd as a whole came down by nearly 30%, in spite of its being maintained under ideal conditions of a dairy farm and fed on the most scientific lines. Although the climate of Bangalore is temperate, provision of facilities for wallowing and daily shower-baths, brought about a marked improvement in their general condition and performance. Again, elevation and wet chilly weather provide an adverse factor for the buffaloes to thrive in, and their performance is most adversely affected. Some of the well-bred high milk-yielding buffaloes, when sent from Bangalore (with elevation of 3,000′) to Wellington in the Nilgiris (6,500′) at a farm, failed miserably in their milk performance, and never appeared to be happy even in their looks, due to both elevation and cold wet climate.

4. Although buffaloes have spread in all parts of the country and are of various types and description, India can claim to possess ten well established breeds with well-defined characteristics and merits. Of these, the following six can claim to be outstanding as milk producers (see photos).

(*a*) Murrah or Delhi breed.
(*b*) Nilli breed.
(*c*) Gir or Jafrabadi breed.
(*d*) Mehsana breed.
(*e*) Surti breed.
(*f*) Nagpuri breed.

The following are the main characteristics and brief description of each of the above important breeds :

(*a*) *Murrah or Delhi Breed.*—Of all the breeds, this breed has spread the most as a prime favourite with milk producers all throughout the country. This is because of its high performance, the ease with which animals of good quality, in any numbers, are available in the market, and its ability to adapt itself to varying conditions and climates. Its home is supposed to be the districts of Rohtak and Karnal, but animals of good quality can be had all over the Punjab. It has also come to be called Delhi breed, because of large numbers of this breed being exported to Bombay, Calcutta and other urban areas all over the country, through Delhi. Of the three classes in which the buffaloes can be divided according to size, *i.e.,* heavy, medium and light, this breed can be classed as heavy. Along with large quantity, it is a consistent milk-yielder and a regular breeder. In conformation, it is well defined, with angular wedge-shaped body, well-shaped and fairly large udder, with prominent milk veins. Its outstanding breed characteristic is its horns, which are universally curved in a spiral and are well placed. As a buffalo, it is docile and not highly strung. It easily forms the largest number in any well organised dairy farm and in city stables of professional milk producers, for reasons given above. It is invariably black in colour, although a little white in the form of a star on the forehead, or a white switch of the tail, is tolerated.

(*b*) *Nilli Breed.*—It is a sister breed to Murrah, probably derived from the same stock originally, but developing a few special characteristics, due to receiving constant attention to its breeding, being confined to a riverain area. It oftentimes passes of by the name Ravi, there being a very subtle distinction between the two. Compared to Murrah, it is a more polished looking animal, with clear-cut outlines in its conformation. Its chief characteristics are tighter curled horns, with wall eyes and the four legs wearing white socks and the switch of the tail also white. It has also a narrower and longer snout than the Murrah. It is a regular breeder, giving an uniform quantity of milk for the major period of its lactation. It is not so easily adaptable to adverse climatic and other conditions as the Murrah, away from its home. It is fairly well distributed in northern India although its home is in the riverain tract of the Punjab rivers. It can also be classed as a heavy breed.

(*c*) *Gir or Jaffrabadi Breed.*—As its name indicates, its home is the Gir forest near Junagard, in Saurashtra (original Kathiawar). It is also commonly, though, wrongly, called Jaffrabadi. The latter is only a port in Saurashtra, but the breed came to derive that name because large numbers of this breed were exported to Bombay for city milk production at one time, from this port, and the Bombay buyers knew the breed by the name of Jaffrabadi. In the past there was such a heavy drain on this breed for milk supply in urban areas, where they were prematurely slaughtered after the lactation was over, that the breed was at one time on the verge of extinction. It has spread itself all over Saurashtra and also in parts of northern Gujerat. A fair number of animals are still to be seen in Bombay City cattle stables. It has well established itself in the Barda Hills near Porbandar (central part of what constituted Kathiawar at one time) and has made the place famous through the Porbandar *ghee,* which is always sold at a premium in the market, The unusually large fat globules in the milk of the Gir breed, as well as the feeding of cotton seed to the milch animals in that area, have given those distinguishing characteristics to the Porbandar *ghee.* In its own home, *i.e.,* the Gir forest, the animals live in the open in the forest area all throughout the year. It is maintained mainly on natural grazing of coarse grass in the forest, which is only supplemented by raw cotton seeds during the hot weather when grazing is scarce. This has made the animal most irregular in breeding and very erratic in its lactation. In some of the animals the lactation period has been found to cover a period of over two years. They mature very late compared to the other buffalo breeds. It is found to yield milk richest in fat of all the milch breeds (inclusive of cows) of India—the highest recorded being as much as 13% fat. Of all the milch animals in the country, it is the biggest in size, some of the animals very nearly touching 3,000 lb. in weight. It is very coarse in appearance, with large pendulous udder and irregular teats. It has a very primitive look about it, which is lent to it by a large protruding forehead and massive horns, which are flat at the roots and take a down slant before sweeping upwards again in a curve. The flat horns grow so tight against the eyes and the face, that sometimes in the old animals the eyes get covered over and the animals get blind. This formation of the horn and the massive forehead are supposed to be nature's protection for the animal against its enemy, which in this case is the lion,—the Gir forest being the only place in India where lions are to be found to-day. Being bred up in the forest of Gir, the animals stand up to humid conditions much better than other breeds. It also thrives on coarse fodder which otherwise would not be acceptable to other animals. As a milk producer it cannot be considered to be an economic animal, due to its irregular breeding, uncertain periods of lactation and the enormous quantities of food it requires. It is so outstandingly different from the other breeds of buffaloes in its conformation that one cannot fail to spot the breed, if an animal of the breed is once seen.

(*d*) *Mehsana Breed.*—A medium-sized breed with its home in the Mehsana District of North Gujerat, from which it derives its name. Being used to scarcity conditions, created by frequent visitations of famines to that part of the country, it is thrifty all round and is perhaps the most economical milk producer amongst all the buffalo breeds. It is constant in its lactation and consistent throughout the period. In other words, there is no marked rise or fall in its daily yield from the time it starts giving milk till it dries up. Its milk has fat globules of medium and uniform size. Its typical colour is black, but some animals have white markings either on the forehead or tail or even legs, but this is not favoured in a well-bred animal. It is blocky and angular in its conformation, and possesses a well balanced udder with uniform teats of medium size. It has medium-sized horns which have a gentle curve all throughout their length. In fact, in their shape they provide a link between the highly curved horns of North India breeds and the straight horns of the South India breeds. Being a good animal all round and an economical milk producer, it was in great demand by the milch cattle stables of Bombay at one time, and this was to a great extent responsible for its marked depletion in numbers from its own home. Even to-day an animal of this breed would be sold at a premium in the urban market.

(*e*) *Surti Breed.*—It is a sister breed to the Mehsana, with its home in the southern portion of North Gujerat, in an area commonly known as Charotar Districts. In good many respects it resembles the Mehsana, the most distinguishing features being its light colour (almost bordering on albino in many animals), but with white band running across the lower portion of the neck. Its horns are more straight than the Mehsanas, with an abrupt curve towards the end. It is a little finer in look, but not so consistent a milk-yielder as the Mehsana. Its home forms a typical area of mixed farming in the country ; as such, the breed plays an important part in the agricultural economy of the tract and this has led to the animals receiving too much individual attention. For this reason they are not found to thrive well elsewhere unless given the same attention, when removed from their home. It is this breed which has made Gujerat and, particularly Anand, famous as the dairy farm of India, forming as it does, the most intensive milk-producing area in the country. Next to the Murrahs, it is to be found in largest numbers all over the country where milk production is undertaken as a profession.

(*f*) *Nagpuri Breed.*—Also known as Pandharpuri or Dharwari, according to the locality in which it is to be found. As its name implies, its home is in Nagpur, but it has trickled down south as far as Dharwar and even further down. In this part of the country it is the best breed known, and for its size it is a good milk-yielder. Amongst the good buffalo breeds of India, it is the smallest. It is a regular breeder, with uniform lactations and can thrive on scanty fodder. In fact, next to the Mehsana it is the most economical milk producer, although its quantitative performance cannot be compared to that of the known North India breeds. It has a conformation with fine outlines and polished look. Its common colour is dark brown or black with the forehead, four legs, and switch of the tail white—what is commonly known as *panchkaliyan*. Its most typical characteristics are its wall eyes and unusually long and straight horns which take a very abrupt and upward curve at the points. With the milk-producers of the south of the Bombay State it is very much in demand and can be considered a suitable breed for the southern or peninsular part of India. Unfortunately, animals of good quality cannot be obtained in that abundant numbers as with the Murrahs or the Surtis, although they are quite adaptable to all climes and conditions.

5. (*a*) *Breeding.*—Compared to the cow, the buffalo is a late-maturing animal, but it has got a correspondingly longer utility life—the average being 13 years. Under normal rural conditions a buffalo heifer on an average will mature at the age of 4 years, although with good feeding and systematic management (as on a well-run dairy farm) this can be considerably reduced and the animal has been found to mature as early as 2½ years. Its period of gestation is 305 days. Its period of lactation varies from breed to breed, as also within the breed. The average can be taken as 250 days but with proper feeding and management it can be brought very near to the accepted limit of 300 days, which is recognised as the standard for purposes of comparison of performance records. The average dry period (*i.e.*, the interval between two calvings) is 194 days, but this also can be reduced along with the period of lactation, by proper feeding and management. There is good deal of variation in the period after which the buffalo comes on heat after-calving, but on an average it takes place after about 100 days and is generally repeated at intervals of 21 days. The duration of the œstral period also fluctuates quite a lot (average being 9 hours) and sometimes the symptoms are so slightly displayed that the heat may be missed. For that reason the best course is to have the animal served as soon as it shows the first symptoms of being on heat after calving, unless it is a very heavy milk-yielder, and a regular breeder, in which case the service may be given on the second or third heat. If the service is not judiciously adjusted, it leads to barrenness in the buffaloes more frequently than the cows. Under natural conditions, the season of calving of the majority of buffaloes is about the month of October.

(*b*) *Feeding.*—Although the buffalo is considered to be a whimsical feeder, it is one animal which will accept coarse fodder and other inferior types of crop residues, which the cow would ordinarily refuse, and convert it into milk. This is one of the reasons why the buffalo remains a prime favourite with the cultivator, as it contributes considerably to his home economics. Being a heavy animal, it requires good deal of bulky fodder.

(*i*) *Feeding of Calf.*—As in the case of other animals, the proper feeding and management of a well-bred buffalo begins from birth. Under rural conditions the calf is seldom weaned at birth, although every effort is made by the owner to make the young one independent of the mother's milk at an early age, so that he can derive as much profit from the sale of milk or milk products, as possible. The male calf as a rule is got rid of by starvation. Under farm conditions the calf is weaned of the mother even at birth ; in that case it is pail-fed. As a rule, a buffalo calf is much more difficult to rear than that of a cow and the mortality ordinarily is rather high (about 25%). To begin with, the calf when weaned is given the mother's milk for the first week or so, then whole milk, which is gradually replaced by separated milk till the calf is able to depend entirely on roughage and concentrates. The following table provides a rough guide to the scale of feeding of a buffalo calf from birth to one-year-old.

> [*N.B.*—The ration scale in the following portions have been borrowed from an article written on Indian buffaloes by Mr. A. J. Lazarus, *Indian Farming*, 1946, 7, 247. The ingredients suggested may be substituted by other types of concentrates available in different localities.]

Scale of rations for buffalo calves

Class of animal	Ragi straw or dry fodder	Green fodder	Lucerne	Groundnut or gingelly or linseed cake	Gram or other husks	Concentrate mixture	Oats crushed or barley crushed	Bran, wheat or rice	Gur or Jaggery	Ginger powder dry	Whole milk	Separated milk	Salt
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	oz.	lb.	lb.	oz.
Calves upto 1 month											6–7		
,, ,, 1–2 months		2–5	1				½	½			6	2	½
,, ,, 2–3 ,,		5–10	½	½			½	½			5	4	¼
,, ,, 3–6 ,,		10	½	1			¾	¾			2	6	¼
,, ,, 6–9 ,,		20	½	¾			½	1					¼
,, ,, 9–12 ,,		20		¾			½ Gram crushed	1					¼
Youngstock 1–2 yrs.	2	28		¼	½		¼	1					½
,, 2–3 yrs.	4	30		½	½		½	1½					½

In pail-feeding the young calf, the important points to observe are;

(1) The calf should be fed at regular intervals during the day and the same time-table should be adhered to from day-to-day.

(2) The utensils used for feeding should be kept scrupulously clean, if any upsetting of the digestive system of the calf is to be avoided.

(3) The milk should be fed fresh and at a temperature round about 98° F.

(*ii*) *Feeding of Young Stock.*—The same principles as have been suggested for the calf should be observed in this case too. Food should not be stinted for the young and growing animal, as any set-back, received by it at this stage cannot be made up by any amount of feeding later on. Providing even a mouthful of green grass would be of distinct advantage to the growing animal. What might be considered a well balanced ration for this class of animal (*i.e.*, young stock from the age of 1 year to 3 years) is indicated in the table given above.

(*iii*) *Buffalo Milk.*—As in the other classes of milch animals, the ration fed should be well balanced to provide for maintenance as well as production. The quantity to be provided for the latter will depend on the quantity of milk yielded by the animal. As far as the feeding of concentrates is concerned, a broad rule to follow would be, that for the first 5 lb. of milk given by the animal, 3 lb. of concentrate mixture may be given, and for every additional 3 lb. of milk, 1 lb. of mixture may be fed. A suitable scale of ration for an average buffalo is given below for guidance :

Ragi straw	Green fodder	Groundnut or gingelly or linseed cake	Gram or other husk	Concentrate mixture	Salt	Mineral or feeding flour
lb.	lb.	lb.	lb.	lb.	oz.	oz.
3	70	¼	1	8	1	½

N.B.—The concentrate mixture should consist of :

Bran	4	parts
Cake	2½	parts
Husk	2	parts
Gram crushed ..	1½	parts
Total ..	10	

(*iv*) *Buffalo Dry.*—Contrary to the prevailing idea, a buffalo when dry, requires as careful a feeding as when in milk as in that stage she has not only to maintain her condition but provide enough nutrition for the developing fœtus. The ration should consist not merely of bulky fodder but a certain proportion of concentrates should also be provided. Great care is needed in feeding as the animal advances in pregnancy, as also soon after it calves. The scale of rations for the above different periods is indicated below :

	Ragi straw	Green fodder	Groundnut or gingelly or linseed cake	Gram or other husks	Concentrate mixture	Bran, wheat or rice	Gur or jaggery	Ginger powder dry	Salt	Mineral or feeding flour
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	oz.	oz.
Buffalo dry ..	3	70			4				1	½
Buffalo down calves ..	3	70			3	3			1	½
Buffalo after calving (4 days only)	3	70				10	1	1	1	½

(*v*) *Buffalo Bull.*—On a well-run farm, the bull maintained for breeding would be a highly bred animal and unless it is fed well, it is bound to deteriorate in condition and would not render the same service expected of him. The following would be a suitable scale of ration for a bull of average size.

Ragi straw or dry fodder, 8 lb.; green fodder, 50 lb.; concentrate mixture, 5 lb.; salt, 1 oz.; mineral or feeding flour, ½ oz.

(*c*) *Management.*—The care and attention required in the management of the buffalo are not very different from those required for the cow, but there are a few special features peculiar to buffalo management, which are given below :

(*a*) In the matter of daily routine, a buffalo is much more sensitive to any slight variations than the cow; as such, any sudden deviations from conditions to which the buffalo is accustomed, such as the time and place of milking, the milker, etc., should be avoided.

(*b*) The buffalo requires copious water supply, both for drinking purposes as well as for its bath. Some suitable arrangements for the latter purpose in the form of running water or a wallow is, therefore, essential, if it has to maintain its health and milking efficiency under average climatic conditions.

(*c*) The buffalo being too much domesticated and having received individual attention for generations is much more sensitve to housing conditions than the cows, as such proper attention is needed to see that it is comfortably housed, especially at night time. Although the tracts from which most of the important breeds come have severe summer, the buffalo needs proper protection against direct sun during daytime.

(*d*) Since the buffalo is a late-maturing animal, it is necessary that the heifer should be served as early as possible. The feeding and management should be so directed that not only the young animal matures early but after calving, the periods of lactations are brought within the accepted standard of 300 days and the dry period reduced to the limit of 90 days.

(*e*) Since the fat content of buffalo milk is very much higher than any other class of milch animal, great care is needed to adjust its rations, so that the maximum quantity of fat the buffalo is capable of giving is obtained. Where the milk is to be converted into *ghee*, this point is of utmost importance. In parts of the country which are famous for *ghee* production, like Porbandar, Hathraj, Etava, etc., special attention is given to the feeding of oilseeds (cotton) and oilcakes, so as to stimulate not only the maximum yield of fat in the milk of the buffalo but of a kind which would give the desired type of firmness to the grains in *ghee*. For, feeding not only enriches the milk but stimulates milk production and it has been the experience that when buffaloes purchased from rural areas are brought to Government and other farms and fed scientifically, their milk performance improves by nearly 25-30% ; so also their butter yield. In the case of heavy yielders (25 lb. and above), milking three times a day is a distinct advantage.

(*f*) Unlike the cow, only a small amount of exercise is needed to keep the buffalo in an efficient milking condition. In fact much exercise adversely affects its milk performance. This is one of the reasons why buffalo is found pre-eminently suitable for milk production in urban areas, where the space is cramped and movement of the animal is very limited.

COW OR BUFFALO ?

By K. P. BASU, Ph.D., D.Sc., F.N.I.

Indian Dairy Research Institute, Bangalore

The question is often asked whether the cow or the buffalo should be encouraged and developed as the milch animal in India. Some people are under the impression that cow milk is nutritionally superior to buffalo milk. The composition of cow and buffalo milk has been the subject of intensive investigation at this Institute. The values for some of the constituents are given below :

The composition of milk

(Average values per 100 ml. of milk)

	Cow	Buffalo
Water in *g.* ..	86·6	84·2
Total solids in *g.* ..	13·4	15·8[a]
Fat in *g.* ..	4·6	6·6[a]
Lactose in *g.* ..	4·9	5·2
Protein in *g.* ..	3·4	3·9
Ash in *g.* ..	0·68	0·70
Vitamin A (International Unit) ..	90–200[b]	130–260[b]
Vitamin B_1 (Thiamine) in *mg.* ..	49	50
Riboflavin in *mg.* ..	150	107
Nicotinic acid in *mg.* ..	81	83
Vitamin B_{12} in mμg. ..	145	78
Vitamin C in *mg.* ..	2·5	2·8

N.B.—Other vitamins like D, E and C, biotin, choline, folic acid, inositol and pyridoxine are also present.

a. In certain parts of India, specially in those where cotton-seed is fed, the fat content of buffalo milk is higher, usually about 7–8 g. per 100 ml. and the total solids content is also correspondingly high.

b. Depending on the season and amount of greens fed.

The main difference between cow and buffalo milk is in the higher fat content of buffalo—it contains 6·6% or more fat—compared with about 4½% fat in the milk of Indian cows. The butter-fat from both buffalo and cow milk possesses almost the same vitamin A activity, although in buffalo ghee it is entirely due to vitamin A while in cow ghee the activity is due to the presence of both the vitamin and its precursor carotene. For the same volume of milk, buffalo milk is richer in vitamin A activity, lactose and proteins than cow milk. On the other hand, cow milk is richer in riboflavin, vitamin B_{12} and phospholipids. Used as a supplement to the typical Indian diets which suffer from multiple deficiencies of vitamins, calcium and good quality proteins, both cow and buffalo milk—if taken 10 oz. per day—balances the diets in the same efficient manner. Thus from the nutritional standpoint, there is very little to choose between cow and buffalo milk and the most important thing is to have adequate amounts of milk—be it from cow or buffalo—for feeding infants and growing children and for balancing the diets of the adult. Because of its high fat content, the buffalo milk may require a little dilution with water before feeding it to infants.

When very large amounts of milk such as for meeting the needs of the urban population are required, such milk should, on economic, hygienic and other grounds, come from the rural areas. The position in rural area is this : if a man wants to keep a buffalo for milk, he must also keep a pair of bullocks for agriculture. The villager is an agriculturist first and buffaloes are not good working animals. If he wants good bullocks, he must have a cow. So, if he could get certain amount of milk from his cows, it suits him better to maintain cows because it serves the double purpose of some milk and bullocks. Generally he is unable to maintain two types of animals. In rural areas, therefore, it seems advisable to increase the milk-yielding capacity of our cows by introducing improved methods of breeding, feeding and management.

Our object should be that ultimately we must make the villages produce large quantity of milk. Although, generally a villager is not in a position to have bullocks, cows and buffaloes simultaneously, in certain cases he may be so. If we can give sufficient inducement to the villager, by making suitable arrangements for taking the milk and for paying him in cash for the milk he produces, he will surely produce more milk either by maintaining better cows or by maintaining buffaloes for producing milk along with his cows and bullocks. A beautiful example of this is furnished by villages in the Kaira District. There the Co-operative Milk Union is collecting all the milk from door to door and they pay cash for milk every day. The lady of the house gets that money and she looks after the buffalo. Quite a large part of the milk supply in Bombay which is about 266 miles away, comes from this district.

The situation is different in urban areas. In cities there is a large demand for milk and since buffaloes generally give more milk than the ordinary cows in India, the maintenance of buffaloes is covered by their production. It is usually not profitable to keep a cow in a city because the ordinary non-descript Indian cows would not produce sufficient amount of milk in order to meet its cost. A high-yielding cow of one of the typical milch breeds in India or suitable cross-bred cows containing foreign blood, which generally give more milk, may possibly be maintained in urban areas but generally it costs more to maintain such cows than buffaloes. Emphasis should, however, be always given on measures to increase the milk production in villages and ultimately we have to look forward to times in which all the milk will come from the villages.

SEPARATED MILK: ITS COMPOSITION, NUTRITIVE VALUE AND UTILISATION

By K. P. BASU, Ph.D., D.Sc., F.N.I.

Indian Dairy Research Institute, Bangalore

Although in this country, *ghee* or the milk-fat is very much prized and sought after as an article of food, there is probably more nutrition below the cream-line in milk than above it. The *ghee* represents only the fat and fat-soluble vitamins (mostly vitamin A and some amount of vitamin D) of whole milk while the separated milk from which the fat has been removed contains all other nutrients of milk, *viz.*, proteins, lactose, minerals and the water-soluble vitamins. While, no doubt, whole milk is superior to separated milk in nutritive value, containing as the former does, all the constituents in separated milk *plus* fat and fat-soluble vitamins, nevertheless, it has been recognised by nutrition scientists that separated milk, which is a by-product in the manufacture of butter, provides valuable nutrients like high quality proteins, bone-forming calcium, riboflavin and other valuable nutrients at a comparatively low cost.

Preparation and Composition

The early methods of separation of fat from milk were all based on the action of gravity in which cream containing the lighter milk-fat was allowed to rise and the cream was skimmed off from the top. The fat content of skim milk obtained in this

The composition of separated milk

(Average values per 100 ml.)

	Cow	Buffalo	Goat
Water in g. ..	90·7	89·9	90·5
Total solids in g. ..	9·3	10·1	9·5
Fat in g. ..	0·1	0·1	0·1
Lactose in g. ..	5·1	5·5	5·0
Protein in g. ..	3·5	4·1	3·7
Ash in g. ..	0·71	0·75	0·80
Vitamin A ..	Nil	Nil	Nil
Vitamin D ..	Nil	Nil	Nil
Vitamin B_1 in mg. ..	49	50	43
Riboflavin in mg. ..	150	107	75
Nicotonic acid in mg. ..	81	83	130
Vitamin B_{12} in mμg. ..	145	78	85
Vitamin C in mg. ..	2·5	2·8	3·5

way is relatively high, varying from 0·3-2·0%. Centrifugal force has now-a-days been substituted for gravity to obtain a separation of milk fat. The intense centrifugal force to which milk is subjected in a modern separator separates it into a skim-milk layer and a cream layer. Separated milk obtained by this method usually contains 0·05-0·3% fat with an average of 0·1%. The following table gives the average composition of separated cow, buffalo and goat milk which naturally, shows some variation. Because of the removal of fat, the percentages of other solid constituents in separated milk are slightly higher than those in whole milk. The difference in the composition of separated cow and buffalo milk is not as pronounced as that between whole cow and buffalo milk.

VALUE AND USE AS FOOD

Human Feeding.—From what has been stated above, it is clear that separated milk contains very valuable food materials and should be utilised for this purpose. Due to the absence of fat and fat-soluble vitamins, separated milk is not suitable for feeding infants and growing children. As a supplement to the typical rice and wheat diets of the adults in India, it exerts striking beneficial effects by supplying some of the deficient factors in the diets, *viz.*, high quality proteins, calcium, riboflavin and other members of the vitamin B complex.

Toning of Buffalo Milk with Separated Milk.—Approximately 54 lakh maunds of skimmed milk are obtained annually in India and a major part of it by machine skimming. Most of it is used for making casein or cheaper type of curd or even wasted. If, however, this skimmed milk could be brought from the production centres to cities where they can be mixed with milk, pasteurised and offered to the citizens for sale as such, it would considerably augment the available milk supply in the cities. Toned milk is quite suitable for feeding infants and children. It may be advisable to add some synthetic vitamins A and D to toned milk.

In Bombay under the Milk Scheme at present about 800 md. of toned milk, pasteurised and bottled, are being sold to the public per day. Nearly one-sixth of the milk handled by the Bombay Milk Scheme is toned milk. Instead of 7 annas that is being charged per lb. of whole buffalo milk, toned milk is sold at 4 annas per lb. This is being made by mixing almost equal proportion of pure buffalo milk (containing about 7% fat) and water and the requisite quantity of imported skim milk powder, to give a mixture containing approximately 3·5% fat and 9% S.N.F.[1] Bottles in which toned milk is sold are rightly provided with a different type of aluminium caps from that used for whole milk. Attempts should be made to bring the separated milk from Anand Dairies to Bombay either in liquid or dried form and use it for preparation of toned milk. It is gratifying to note that the Kaira District Co-operative Milk Producers' Union at Anand, in collaboration with the United Nations Children's Fund (UNICEF), is setting up a modern dairy and milk drying plant at Anand.

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[1] Solids-not-fat.—*Ed.*

Cow milk, because of its lower fat content, is not suitable for toning by either of the above procedures.

Calf Feeding.—Separated milk is also very useful for feeding calves and attempts should be made to substitute suitable gruel mixtures containing separated milk for whole milk fed to calves so as to make more whole milk available for human feeding. Experiments in this line are being carried out at the Indian Dairy Research Institute.

Condensed and Dry Separated Milk.—Separated milk may be utilised in raw, condensed or dried form. Condensation and drying enable us to preserve the constituents of separated milk for a long time and also to reduce transport cost.

Use in Baking and Confectionery Industries.—Dried skim milk powder has been successfully used in baking and confectionery industries.

Ordinary bread is a nutritionally unbalanced, predominantly carbohydrate food. Spreading butter on this bread corrects its deficiencies in fat and vitamins A and D. The addition of non-fat milk solids to the bread provides an almost perfect supplement to correct the remaining dietary deficiencies. Most vegetable proteins are deficient in one or more of the essential amino acids and wheat flour proteins are lacking in adequate amounts of lysine and tryptophan. The addition of 6% of skim milk solids not only significantly raises the protein content of the loaf from 8-9·6%, but also supplements these deficient amino acids, particularly lysine. This addition would also raise the calcium content of the bread from 30-90 mg./100 g. and of riboflavin from 0·2-0·8 μg./g.

The Germans started studying the use of skimmed milk powder in the early thirties and both in the public bakeries of Nuremberg and in the military bakeries of Reichswehr, 3% of milk powder is reported to have been added to the daily bakings. To-day a firm in Nuremberg makes a special kind of bread using some 2 million gallons of skimmed milk every month. But it is in the United States that the widest use is made of milk in bread. In 1939 no less than 160,000 tons of skimmed milk were used by bakers in U.S.A. in the manufacture of bread and cakes. Something like 60% of America's output of non-fat dry milk solids is used in bread in which 3·5% skim milk powder is incorporated on an average. Consumer acceptance trials in Canada and in the U.S.A. have shown that the higher the milk content, the greater is the amount of bread eaten. The highly enriched American type loaf is, however, very sweet and this, together with its high percentage of shortening, makes the bread somewhat resemble cake.

An attempt was made some years ago to add milk to bread in Australia but initial experiments did not meet with success. This was due to the failure to add the cane-sugar and fat matter which the Americans add. Commercial trials with 6% of skim milk powder containing 0·02% potassium bromate, 4% fully hydrogenated stearin, and 1% glycerol monosterate, incorporated in ordinary white doughs, showed it to have excellent baking qualities. Skim milk powder of this type is now being produced in Australia.

Preparation of Casein and Lactose from Separated Milk.—If the separated milk develops too much of acidity and undesirable flavour so that it cannot be used directly as food or for preparing skim milk powder, valuable materials for industrial use may be prepared from such skim milk. When separated milk sours, or a small amount of acid or the enzyme rennet is added to milk, a white precipitate of casein is formed. The whey is removed by pressure and the casein is washed and dried.

Rennet casein is usually used as the raw material for casein plastics from which articles such as buttons, fountain-pen barrels, knife-handles, combs, umbrella-handles, etc., are often made. Acid precipitated casein may also be used for this purpose. Casein is also used for making casein glues and cements specially in the plywood industry. Casein textiles are also being developed.

Casein is a protein with high biological value and is used in a number of proprietary foods like sanatogen.

The whey obtained after the precipitation and separation of casein can be utilised for the making of lactose. Besides being used in baby foods, lactose is essential for the manufacture of penicillin. The daily requirements of 1,500 lb. of lactose for the Indian Penicillin Manufacturing Project can be met by producing it from the whey from separated milk and *chhana*[2] in this country and its import can be avoided.

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[2] *Chhana*: Coagulated milk proteins used in the manufacture of sweets in North India.—*Ed.*

BUTTERFAT TEST AND ITS USE IN CATTLE IMPROVEMENT

By Dr. NOSHIR N. DASTUR

Indian Dairy Research Institute, Bangalore

Butterfat is economically and commercially the most important constituent of milk. The development of the modern dairy industry has in a large measure been attributed to two outstanding discoveries, namely, a simple yet accurate method for testing butterfat in milk and the cream separator. The butterfat test is useful to a herdsman directly and indirectly in several ways. For this reason it is always included in milk testing and herd improvement programme. In judging the performance of a milch animal, the quantity as well as the quality of milk are equally important. The advent of a simple method for testing fat in milk provided a much sought for equitable basis for the payment of milk purchased either for the liquid trade or for manufacturing purposes. A fair basis of payment for milk according to its fat content inspired sufficient confidence in the producers and gave the much-needed impetus to the dairyman to produce more milk of better quality, and thus establish a flourishing dairy industry. With the help of the butterfat test, it is possible to obtain an accurate idea about the daily performance of each animal in regard to fat content of milk and fat output; to judge the persistency over the whole lactation and evaluate the overall economic potentiality of the animal ; and to feed the animal adequately and economically based on its performance at the pail. Further, from a careful record of the fat percentage and fat output, the potential output of the herd could be improved from year to year by judicious breeding and culling.

Apart from the above direct uses of the butterfat test, it has other uses on a farm where milk is handled. Butterfat test can be employed for checking the fat losses in the preparation of such products like cream, butter, *ghee*, etc. Similarly, the test could be used to safeguard the quality of market milk and to detect skimming and adulteration with water. Again, from a knowledge of the specific gravity of milk and its fat percentage, it is possible to calculate with fair accuracy the total solids and solids-not-fat content of milk, which gives a much better indication of the milk quality than fat per cent. alone.

One of the methods commonly employed for the determination of fat in milk and other milk products is the Gerber test. In this method 11 ml. milk is shaken with 10 ml. of strong sulphuric acid ((Sp. gr. 1·825 at 60° F., or 90%) and 1 ml. amyl alcohol, in special tubes called butyrometers. The butyrometers are graduated to read the fat percentage direct. The strong sulphuric acid acts upon the non-fatty milk constituents bringing them into solution. Amyl alcohol present facilitates the easy separation of fat on the top in a clear layer when the tube is centrifuged. The method though simple is accurate provided care is exercised in regards to the details of the working. The operations could even be carried out by a non-technical person. Depending upon the volume of the samples handled, either a small hand-driven or a large electric centrifuge could be employed. For use in the field, compact Gerber units are also available. The cost of a small outfit will be about Rs. 300. It is not necessary that the milk of each animal, or from each producer, should be examined every day. To economise in cost and time, composite weekly samples may be taken for analysis and the total output per week calculated without the loss of accuracy. The cost of performing a Gerber test is roughly about 3½ annas including the pay of the technician. Considering the benefits likely to result from the introduction of such a practice, this cost is negligible. It has been truly said that the butterfat test raises dairying from a primitive art to the realm of science. It is hoped that in the new programme for the improvement of our cattle and production of more milk, which is being followed with such enthusiasm all over the country, wider use of the butterfat test will be made.

PREPARATION OF GHEE AND ITS KEEPING QUALITY

BY DR. NOSHIR N. DASTUR

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GHEE is the most important product of milk. Nearly 43% of the total milk produced, or 68% of the milk used for the manufacturing purposes, is utilized for making ghee. The approximate value of ghee produced per annum will exceed Rs. 175 crores. Therefore, improvement in the quality of ghee is of far-reaching economic importance especially as the bulk of the product comes from villages.

PREPARATION OF GHEE BY THE INDIGENOUS METHOD

Though ghee is prepared by the same method throughout the country generally known as the *desi* method, the care bestowed during handling and manufacture at various stages beginning from the production of milk varies. This in turn influences the quality of ghee to a considerable extent. For the preparation of ghee having long storage life and rich in vitamin, cleanliness at every stage is important. Milk should be boiled, preferably simmered for 5 minutes, and then cooled to room temperature in a covered vessel. For souring milk, it should be inoculated with a small quantity of good *dahi* or buttermilk which act as starter. A good starter has a pleasant acidic flavour ; is free from gas holes, too much acidity, and shows a compact texture with no appreciable separation of whey. Starter supplies the organisms responsible for the production of acidity, curdling of milk and development of flavour. Starter containing harmful organisms bring about undesirable changes and lowers the yield and keeping quality of ghee. Boiling of milk is done with the same object, namely, to eliminate harmful bacteria which may be present in milk.

After inoculation, milk should be allowed to sour in a covered vessel kept in a clean place. The curd should be churned preferably within 24 hours after souring. Churning must be carried out in a covered place after spraying the ground with water to avoid contamination from dust. During churning, cool water is added at intervals so that the total volume is equal to that of the milk taken. It is important to avoid overchurning as the yield is lowered and butter tends to retain more moisture. After gathering the butter it should be washed twice with water. It is desirable to melt butter into ghee on the same day. When this is not convenient, butter should be stored under water in a covered vessel. The storage period, however, should not exceed 2 to 3 days. Butter should be heated briskly on a non-smoky fire with occasional stirring. The final temperature of heating varies from nearly 100° C. to 125° C. or even higher. Heating to high temperatures is not desirable as the natural colour of ghee is impaired and such a product has a tendency to develop oily flavour during storage. Generally under household conditions, heating is stopped when the sediment begins to turn brown. Sometimes betel leaves or drumstick leaves are added just near the end of the heating period when the effervescence ceases. Similarly, clovers, cardamom and *jaggery* are also used. These substances impart a slight colour and flavour to ghee. In some places during heating a special variety of red earth is used to help clarification. Again, during storage there is a practice to add a lump of salt under the belief that it increases the keeping quality. Experience, however, shows that such additions are not at all necessary for the preparation of good ghee.

Ghee put on the market is generally blended, *i.e.*, ghee from one or more centres may be mixed to give the desired marketable qualities. During blending ghee may be heated to about 110° C. Sometimes the temperature is not allowed to rise above 80° C., but warm ghee is kept for longer interval in tall vessels to allow moisture and other impurities to settle down. The main criteria used by the consumer in selecting ghee is its aroma and to some extent colour and texture. Aroma is largely determined by the care exercised in souring milk and the temperature of heating. Colour depends on the type of milk used. Ghee from cow milk has yellow colour because of the presence of carotene, whilst buffalo ghee has very pale colour. The grain structure is a physical phenomenon and under commercial conditions it is brought about by controlling the rate of cooling melted ghee before the containers are sealed.

OTHER METHODS OF MAKING GHEE

Ghee can also be made by directly heating cream containing high proportion of butterfat, or from creamery butter. Cream is prepared by passing milk through a cream separator. To obtain butter, cooled ripened cream is churned in a butter churn. Butter obtained is "worked" to remove excess moisture. However, the quantity of ghee thus produced is negligible. These methods have much to commend as the process could be more easily controlled under factory conditions when large quantities of milk are handled and the loss of butterfat is considerably reduced. Due to the use of cream separator and better control in the manufacturing process, the loss of butterfat is reduced from 15 to 20% in the *desi* method to about 7%. However, ghee made by the *desi* method on account of its peculiar aroma finds preference. It has also been observed that ghee made by the indigenous process is richer in colour, whilst cream and creamery butter ghee have lighter colour. The difference is particularly noticeable when buffalo milk which does not contain any carotene is used. This enhances the marketable quality to some extent. It may be added that *desi* butter contains a larger amount of curd which in turn gives proportionately more residue on heating. The residue also contains more entrenched ghee than in the other two processes. It is, therefore, desirable that the residue obtained during ghee making should be utilized profitably and not thrown away as waste.

In all the three methods it has been found that lot of fuel is wasted in removing moisture present. Due to prolonged heating the flavour of ghee also suffers. To remedy this, the method of melting butter has been recently modified at this Institute. Butter is melted in a container provided with a drain tap at the bottom. When held under warm conditions most of the moisture and curd settle and are drained out. The butterfat which now contains very little moisture and some curd is heated in the usual manner. Due to lessening in the time of heating, ghee with better flavour and longer keeping quality is obtained. This method, therefore, deserves to be used more widely especially when larger quantities are handled.

KEEPING QUALITY OF GHEE

Ghee prepared under careful conditions is rich in vitamin A and can be kept for 6-8 months if stored properly irrespective of the method used for its preparation. It is, however, essential that moisture be removed properly. During the various stages of manufacture and storage, there should not be undue exposure to air and light. Similarly, the use of iron, brass or bronze containers should be avoided. Mud pots can be used for storing milk and preparing curds and butter provided they are thoroughly sterilized by boiling water after using each time. Porous pots are not suitable for storing ghee as there is free access to air. Metals named above accelerate spoilage of ghee. When iron or brass vessels are used they should be properly tinned. Most suitable containers for keeping ghee are new tins, porcelain jars or aluminium vessels with a narrow opening. The container selected should be such that there is not much air gap when ghee is stored. Small quantities of ghee can be removed for day-to-day use.

Ghee prepared under unhygienic conditions suffers from several defects, the main amongst which are presence of free fatty acids and rancidity due to oxidation. Normally ghee is a rich source of vitamin A. These changes are accompanied by destruction of vitamin A of which ghee is a rich source. It has been found that when milk is not boiled and butter stored for 5-7 days without washing or dipping in water, the ghee obtained contains 40-50% less vitamin A than otherwise. Similar changes are produced in presence of air and the rate of destruction and production of off-flavour are accelerated when light is also present. It is for these reasons that many samples of ghee coming to the market are at best poor sources of vitamin.

In the trade it is a common practice to store *kaccha* ghee without being heated to the final temperature and hence containing large amount of moisture. Presence of moisture and curd serve as food for bacteria which in turn bring about considerable decrease in the nutritive quality of ghee. This practice must be discouraged. Further it is not desirable to heat ghee repeatedly. All the moisture should be removed at the first heating. For blending, ghee need then be heated at much lower temperature and packed after filtering.

Quality of ghee once spoilt cannot be improved. It is therefore essential to see that cleanliness and simple precautions as outlined above are observed at all stages of manufacture and storage.

SCOPE FOR FISHERIES DEVELOPMENT IN MYSORE STATE

By Dr. H. D. R. IYENGAR

Mysore State Department of Animal Husbandry

It is a common notion among the general public that fisheries development is synonymous with the presence of a seacoast and that to speak of fisheries development in an inland State like Mysore is unthinkable. When the foregoing report is read through the above misconception will be easily dispelled.

Inland fisheries development is part of our national plans. In the First Five-Year Plan, the following inland States have programmed to spend a total of Rs. 391·9 lakhs on inland fisheries.

	Rs. in lakhs		Rs. in lakhs
Uttar Pradesh	165·20	Hyderabad	8·56
West Bengal	78·80	Travancore & Cochin	8·00
Madras	40·00	Assam	6·00
Punjab	18·00	Madhya Pradesh	5·84
Bombay	15·98	Madhya Bharat	5·00
Orissa	13·05	Delhi	2·87
Bihar	10·06	Pepsu	2·36
Saurashtra	10·00	Mysore	2·20

Even though, the scope for fisheries development is very pronounced in Mysore State, uptil now, only a token attempt has been made in this direction. The object of this report is gained when the attention of the public is drawn to this new aquatic, protein rich, food resource.

WATER AREAS AVAILABLE FOR FISH CULTURE

Mysore State has an annual rainfall of 36·2″. Being situated on an elevated plateau of over 2,000′ above sea-level, the rain water falling from the two monsoons is drained mostly into the Bay of Bengal through three main river systems. Thirty per cent. of the rainfall is held back for irrigation and other purposes in a system of tanks and reservoirs. For an area of 33,310 square miles, Mysore State has 2,621 major tanks, 19,982 minor tanks, 14 reservoirs, 2,282 miles of rivers and 1,500 miles of irrigation channels. These water areas are the potential sources where pisciculture could be extensively developed. Thus a total of over 9,66,000 acres of water spread is available for fish culture. Even if only one-fourth of this area is brought under intensive fish culture, over 6,000 tons of fish could be produced annually.

Mysore State has a population of 98,48,684 out of which over 82,00,000 are fish-eating. At 12 lb. per annum per head, for a population of 10 lakhs, 6,000 tons of fish are required annually. It is possible to produce this fish requirement of Mysore State within its water areas.

Nature of water-shed	Number	Acres of water-spread	Acres available for pisciculture	Productive capacity in tons
Tanks ..	22,603	6,87,000	1,69,000	4,200
Rivers and channels	2,280 miles	1,50,000	50,000	800
Reservoirs ..	14	1,29,000	50,000	1,000
Total ..		9,66,000	2,69,000	6.000

FISHING METHODS AND FISHERMEN IN MYSORE STATE

There are twelve methods of fishing employed in the State. Most of these methods are in shallow waters employing individual or small groups of fishermen. The chief methods of fishing are the use of *Cast net, Drag net, Gill net, Prawn net, Plunge basket, Basket trap, Long lines and Country rods.* The fishing season is during the flood season in rivers and in summer months in the tanks. Thus fishing is carried on during March to October and during November to February, there is practically no fishing. Most of the fishes breed during the monsoons, *i.e.*, from June to August. Most of the reservoirs are not at all fished for want of deep water fishing equipment.

There are nearly 4 lakhs of part-time and full-time fishermen in the State. They are :

Besthas	1,75,300
Uppaligars	1,16,000
Thigalas	91,000
Burudebesthars and others	45,000
Total ..	4,27,300

The most interesting community of fishermen in the State are 45 wandering batches of Burudebesthars who travel up and down the river valleys fishing throughout the year. These are the nomadic batches who periodically immigrate into the State and indulge in deep water fishing. Their gear and mode of fishing is unique and found in only this region. They use floats made up of dried gourds and sealed kerosene tins to negotiate into deep waters and use a wall-net for catching fish. They ride on the floats and propel themselves by paddling with their legs in the water. These are the only group of fishermen that do fishing all through the year. The other fishing communities do fishing only part of the year as they are primarily indulged or employed in other agricultural operations.

FISH FAUNA OF MYSORE STATE

The fish fauna in Mysore State comprises over 140 varieties; of these nearly 50 are important as food fishes. The fish fauna may be roughly divided into seven groups as following:

I. CARPS.
II. MURRELS.
III. CAT-FISHES.
IV. EELS.
V. LOACHES.
VI. EXOTIC FISHES.
VII. OTHERS.

CARPS

These include over 40 varieties and all of them have scales and are popularly called in Kannada as *Gende meenu*. The fishes range from a few inches in size to 3-4′ and weigh from an ounce to over 100 lb. each. The carps have lot of intramuscular bones and as such are regarded by the people as very "thorny". The best known of the carps is the *Mahaseer* or (*Barbus tor* ಬಿಳೀ ಮೀನು). This is world renowned as a game fish. The *Mahaseer* found in the Cauvery and its tributaries is exclusive and much sought after by anglers all over the world.

Among the food fishes, the following are the important carps. These grow from 5-12 lb. each.

Barbus carnaticus	(ಗೆಂಡೆ)	
Barbus dubius	(ಕೂರಲು)	Found only in Cauvery drainage.
Barbus neilli	(ಹೆಳ್ಳ)	Found only in Thungabhadra drainage.
Barbus tor	(ಬಿಳೀಮೀನು)	
Labeo fimbriatus	(ಮಚ್ಚಲು)	
Labeo calbasu	(ಕೆಮ್ಮೀನು)	

The minor carps which grow to less than a pound are:

Barbus sarana	(ಗೆಂಡೆ ಪಕ್ಕೆ)
Cirrhina reba	(ಅರ್ಜಿ)
Garra jerdoni	(ಕಲ್ಲುಕುರಿ)
Barillius bendelisis	(ಅಗಸಗಿತ್ತಿಮೀನು)

MURRELS

There are three important varieties of these fishes in the State. These fish have small scales on the body and enlarged scales on the head and are sturdy. They are capable of living outside the water, for a considerable period. The fish are characterised by the long dorsal and anal fins which are spineless. The fish are valued as food, as they have a very tasty flesh with very few intramuscular bones. The fish are found in all the tanks in the State and breed prior to and during the monsoons. These fish are known for their parental care, since they guard the eggs in the nest till they are hatched. Very easy for culturing and marketing.

Ophicephalus striatus (ಕುಚ್ಚು).—Ranges from 2-5 lb. and grow to 3′. The fry of this fish are orange red in colour, later on they turn greenish and when adult develop the characteristic. This is a very valuable food fish. The fish take a bait very readily.

Ophicephalus marulius (ಹೂವು ಮೀನು).—These also grow to 3-8 lb. Differ from the strains in body colouration. There are flower-like dark rings in either side of the body and on the caudal fin. The fry are dark in colour with an orange lateral streak on the sides.

Ophicephalus punctatus (ಕೊರವ).—It is the smallest of the murrels growing to about ½ lb. and 6-8″ in length.

CAT-FISHES

These include over 12 varieties and all of them are scaleless and have flesh with very few bones, as such they are very much desired as food fish. These fish prefer muddy waters to clear water and are capable of living outside the water for a considerable number of hours, as they have facilities of storing fresh air in their mouth chambers. These being air breathers can be transported to long distances with ease. The eyes of these fishes are disproportionately small and poorly developed. The absence of good sight is counterbalanced by the exaggerated sense of touch. These whiskers are sensitive and are used in locating the prey as well as to stay out of trouble.

Wallagoo attu (ಬಾಳೆಮೀನು).—This is a fish notorious for its predatory habit. It is found in the Cauvery drainage and some of the larger tanks. The colour of the fish is uniform grey somewhat darker above and lighter beneath. It is a straight-backed fish. It has two pairs of whiskers, the one on the upper jaw being the longest. The fish grows to 6′ and is a very good game fish. It is also called the *fresh-water shark*.

The Callichrous (ಗೊದೆ).— It is popularly called the butter fish because of its excellent flesh. These grow to a pound and about 1′ in size and are found in almost all tanks.

Saccobranchus and Clarias (ಚೇಳುಮೀನು).—They are black fish growing to about ½ lb. in size. These have stout long whiskers around the mouth and have small eyes. Each pectoral fin has a spine which has a poison gland in its face. When the fish strikes with these pectoral spines, the resultant pain is akin to the sting of a scorpion, hence the name "Scorpion fish".

Macrones (ಗರ್ಲು).—These fishes whose sizes are from a few inches to a few feet are found in almost all tanks in Mysore State. The fish have four pairs of barbels, the snout of the fish, chisel-shaped. These fish are very good to eat.

EELS

These are snake-like fish. Here are two varieties in the State. The pure eel or *Anquilla bengalensis* and the spiny eel *Mastacembelus armatus*. The latter is the commonest and is found in tanks and rivers. The former is confined to the Thungabhadra river and Palar Basin. The spiny eels are caught in traps in the Sulekere area. These fish are excellent as food and grow to 3-4′ in size and 5-6 lb. in weight.

LOACHES (ಮುಳ್ಳಿಮೀನು)

These are small fishes only a few inches in length with soft flesh. Found in rivers and tanks, used as food fishes. There are seven varieties of these fishes which support a large rural fishery.

EXOTIC FISHES

Since a decade an attempt has been made to introduce fishes imported from other States. These fishes are well known for their food quality and are undoubtedly well suited for fish culture in small water-sheds. The experiments have been successful and we are now in a position to advocate the introduction of these fish for cultural practices in certain selected areas.

So far four varieties have been introduced in the State, namely, *Catla catla, Etroplus, Mirror carp* and the *Gourami.*

(*a*) *Catla.*—This is a major carp native of the Godavari and northern rivers. It is the quickest growing carp. It grows to over 50 lb. These have been introduced in Markonahally, Markandeya, Hessaraghatta and Krishnarajasagar reservoirs. The *catla* have thrived well in Mysore waters but have not bred. They are expected to breed in Krishnarajasagar.

(*b*) *Etroplus.*—It is a very colourful fish flattened from side to side. This grows to 1-2 lb. and is known to have very tasty flesh. These fish are primarily brackish-water fish now acclamatised to fresh-water. They have done very well in Markandeya reservoir, where they have been breeding. The Ulsoor lake in Bangalore is also stocked with this fish.

(*c*) *Gourami.*—These are natives of Java and are now established in South Indian waters. These fish are introduced in Markonahally, where they have bred. These, like the *Etroplus*, are flattened fish from side to side and grow to about 2 lb.

(*d*) *Mirror Carps or the German Carps.*—It is a very desirable fish growing to 8 lb. These were imported from Ootacamund and are thriving well in Nandi Hills and Hessaraghatta. The food value of this fish is equivalent to any of the major carps.

SCOPE FOR FURTHER DEVELOPMENT

Scope for developing and establishing a fisheries industry in the following reservoirs is very great ;

Krishnarajasagar
Hessaraghatta
Thippagondanahalli
Bellandur Tank
Vanivilas Sagar
Thunga
Bhadra
Thungabhadra
Sulekere
Anjanapur
Hirebhaskar
Markonahally
Bethamangala
Markandeya
Ramasagara
Boranakanive

Every effort should be made to attract fishermen into these water areas for developing and exploiting the rich fishery resources. Employing fish culture in a programme of mixed farming is a profitable venture. A farmer can raise 50-1,000 lb. of fish in an acre of water spread, depending on the amount of fertility obtained in the water. It is possible to earn over Rs. 100 net per acre of water excluding expenses, if fish culture is resorted to. Fish can also be cultured in the standing water in paddy fields.

Thus, scope for fisheries development in Mysore State is bright. What we need is investment in an agency to popularise this aspect of agriculture.

It is befitting of an enlightened administration to focus its attention on this aspect of national development. Any programme for fisheries development should include :

1. Survey of fishery resources.

2. Hydrobiological research of selected waters and research into fishing tackle and gear.

3. Establishment of fish seed collection centres, fish farms and fish seed distribution units.

4. A programme of stocking and exploitation of productive waters.

5. Rehabilitation of fishermen by providing small loans, fishing equipment, yarn, hooks and colonising facilities.

6. Enforcement of conservative measures to prevent illicit fishing, destruction of fish fry and loss of revenue to Government.

7. Creation of an agency with adequate funds, powers and other facilities in implementing the above programme.

8. Consolidation of fishery revenue so as to make the entire programme of fishery development remunerative in course of years.

FUNCTION OF FORESTRY

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INTERNATIONAL standards suggest that the forest area of a country should be at least 25% of the land area. For India we have about 2,42,000 square miles of forests representing about 19% of land area. In Mysore State we have only 15% of area under forests. The national forest policy that is taking shape, suggests that it is desirable to have 60% of area under forests in level tracts of the country.

About 75% of the forests in India are owned by the State and 71% of these forest areas are under the control of Forest Departments. In Mysore State almost all our forest area is State-owned. Our population is largely agricultural and the status of our agricultural lands is well known. The importance of forest lands for the economy of the country and for agriculture is hardly realized. In 1951, the census showed that the population of the State had reached 90,72,000. The same year, over 1,700 acres of forest land had to be handed over for the demands of agriculture. These happenings are annual features and clearly indicate that the need for forest lands is not realized. Further, in 1948, all forest lands were thrown open for free grazing all the year round as a result of popular demand. In these battles, naturally the forest scientist was never the best friend of the agriculturist.

The practice of Forestry is highly specialized, needing technical skill. Every citizen should have an understanding of the subject in order to safeguard our own future interests and to enjoy the current benefits fully.

Forestry is the "science and art of integrating relations between human welfare and forests". Very broadly, three main branches can be formed for this subject—Sylviculture, Management and Utilization—all of them aiming towards deriving a maximum sustained benefit, perpetually from our greatest of renewable resources.

BENEFITS FROM OUR FORESTS

From the earliest of times man has derived benefits from forests. Early history of our country makes this point more clear. The records of Megasthenes and the *Arthasastra* of Kautilya, reveal that forests were managed for the sake of benefits, by a system of classification.

Very broadly, forests serve three distinct purposes: æsthetic, protection and production. In the grandeur of the forests there are many opportunities for recreation and relaxation. They are the home of wild life. In the role of protection, they help to check the rains and prevent erosion and floods, and insure a steady flow of water for agriculture and domestic purposes, as well as for our expanding Hydel Projects. In the field of production, forests play a leading part in the economic and industrial life of the nation. Besides providing timber, fuel, bamboos and grazing, our forests are sources of many other products like barks, herbs, fruits, roots, etc., of great value and importance.

If we were totally deprived of our forests we would be miserable, suffering æsthetically, physically and economically. Therefore we should have a general knowledge of the practice of forestry in order to help ourselves to the benefits perpetually. Without the proper background it is neither possible to practise forestry, nor to appreciate its diverse problems.

THE BRANCHES OF FORESTRY

Fig. 1 shows the branches of forestry and the relationships between the applied forest science subjects. These specialized sciences applicable to forestry are built upon the solid foundations of the basic and fundamental sciences. Forest management is dynamic and depends on a correlation of all economic and technical facts in the execution of work planned for the needs of the country. Forest management is often called the "keystone of the arch".

Of the three main branches, Sylviculture is the art and science of cultivation of forests for the requirements. Utilization deals with making the best use of forest products and has a bearing on Silviculture and also on Conservation of natural resources. Management decides the details of the area for working, age of trees for felling and matters cognate to the actual plans for execution and has a direct bearing on forest economics and finance.

SYLVICULTURE AND MANAGEMENT

It is emphasised that the primary duty of a forester is to maintain the productive capacity of the site. Of natural communities and their environments classed as our natural resources, soil is one of the most important. Forestry and agriculture are both dependent on the soil. Soil and vegetation are closely interrelated. They are both products of environmental influences, developed over long periods of time. When natural communities and their environments are disturbed slightly, there may be chances of recovery, but if they are modified highly or are destroyed, a recovery may become impossible. In fact, catastrophic natural events may be precipitated with far-reaching consequences.

It is therefore necessary that in our endeavours to utilize the functional feature of the soil, namely, its productive capacity, to the maximum extent, we do not jeopardize the needs of the future, Thus, if our needs force heavy modifications of the forest community by means of strong inroads into forest lands, and if over-felling, over-grazing, burning and such destructive influences go unchecked, the forces of nature are unleashed into floods, erosion, sinking water tables and devastation of property (see photos).

If we restrict our activities by mobilizing available knowledge, and by recognizing biological concepts, we may hope to maintain our current natural resources and regenerate that which we have destroyed. This is precisely the aim of Sylviculture. Sylviculture is an application of œcology. On the basis of œcological principles, the site and the crop are built up and maintained using artificial or natural means. Studying the soil, and the composition and condition of the forest "Sylvicultural Systems" and Sylvicultural operations are devised for achieving the objectives in view. In all these operations, great emphasis is laid on creating and maintaining a continuous vegetative cover on the soil without allowing any lasting gap to occur. Consistent with these principles, Sylviculture cultivates and regenerates the forest for our requirements. Sylviculture has many features in common with Agriculture. The same area is used over and over again. The farmer may refresh his soil with manure—artificial or natural. But in the forest, the dropped leaves and twigs decay into a rich humus and restore the fertility of the soil.

An agricultural crop is essentially a short rotation crop—generally taking under a year, and the farmer takes away the entire crop. A forest crop takes years to grow to harvesting stages. It may take 10-12 years in some short rotations and may go up to over 150 years in other cases. In any case the forester can arrange for an annual harvest. This is where "Forest Management" comes. Over an area the forest may be developed and worked to consist of all ages of trees arranged in regular blocks consisting of the various constituent age classes ranging from seedlings to mature trees in correct proportions, or there may be trees of all ages all over the area everywhere. The former type is called an even-aged stand and the latter a selection type or uneven-aged stand. A forest with such a normal distribution of age classes is called as a "Normal Forest". It is possible to interchange these types by special methods of conversion under Sylvicultural systems.

Forest management systematizes the execution of the work and financial aspects of the forest into something like operating on a bank account. The trees now standing in our forest form the "Capital" and the wood that is grown by these trees annually forms the "Interest". The capital and interest are both "Woody" of course and are termed as the growing stock and increment. We can take the same interest annually and utilize it keeping the capital intact, unless we start eating into the capital. The calculation of this interest in terms of the sum total of the annual woody growth and to translate it into the number, age, size and position of the trees to be felled in the forest, consistent with the objects of protection and soil conservation and to balance this with the demands of the market is the task of the "working plan" in the field of Management. Does this not sound like possessing the cake, and eating it too!

Management has also to keep a watchful eye on the financial aspects. The yield should be commensurate with the amount of expenditure incurred on the operations involved until the stage of harvesting and should economically be a steady and justifiable return.

As the prescriptions of the working plan are being executed, control is also to be exercised in order to allow only justifiable deviations. Deviations may be forced by sudden and unforeseen circumstances, like wars, a devastating fire, epidemic attacks by various enemies of the forests and so on. When these occur the whole plan is thrown out of gear and may need revision to form and maintain a "Normal Forest" with a proper, normal distribution of age classes. It is only from a normal forest that a sustained yield may be obtained perpetually in equal annual quantities, and it is in a normal forest that the yield cut is replaced each year by the annual increment.

Sylviculture and Management have been briefly outlined without entering into technicalities and ramifications. We have barely scratched the surface. There are various types of increments and rotations for application to individual cases. These are beyond the scope of this paper.

UTILIZATION

Wood is the major forest product. There are other products termed as minor forest products including sandal, bamboo, cane, barks, fruits, etc.

Wood is a versatile material. It can give us shelter, fuel, food and clothing. It can give us conveyances for our transport. The last war was fought and won with wood. Wood provided material ranging from the softest tissue to the hard metal like plastics. It gave materials for explosives, paper, boards, wrappers and such required in thousands of tons. It provided buildings, planes, ships and hundreds of tools.

From tooth picks to transmission line poles, from matches and pencils to railway sleepers, furniture and wheels, wood is used as such. Wood is modified and used in many other forms for other purposes.

Man has always depended on wood. His first mechanical devices —the lever and the wheel—were made of wood. From the cradle to the grave, man has been using wood. There are over 4,000 ways in which man uses the material of which trees are made, in this world of ours.

Paper comes from the produce of our forests. Plywood, various kinds of modified wood and paper, and plastics originate from wood. With our developing population and increased standards of living we cannot afford to waste any renewable resource.

Utilization takes all these matters into account, and works towards developing complete and maximum uses for our forest products. Current markets must be held and others developed, so that the yield of the normal forests described, will be economically and financially sound. Many shortages of non-renewable resources may be faced by mobilizing wood or its products. These aims are towards conservation of our natural resources, by extending their utility.

Utilization requires a good background of Science and Engineering. It is a mistaken notion to think that utilization destroys and works against the preservation of our forests. We must not think of forestry in terms of the preservation of our forest wealth. We should maintain and use the forest wealth intelligently and with care.

Because of many reasons, we cannot expect such large trees as we could get about 30 years ago. Man and wood both had many limitations. Modern science and engineering have come to the rescue of both and the future is now very bright indeed. Wood has directional properties. That is, its strength is not the same along and across the grain. Wood swells and shrinks very much across the grain and very little along the grain, as the moisture content fluctuates with the surrounding atmosphere. By various physical and chemical means these limitations of wood can be got over. By such means the durability of wood can be improved upon and its inflammable qualities stepped down.

In former times when large trees were common, they had to be cut to size. Now, with smaller sizes, large sizes can be constructed by joining pieces. Owing to new developments, the joint in wood need no longer be a source of weakness. A wood beam with jointed structure need not be inferior in qualities when compared with a solid wood beam. Wooden panels wider than the width of any tree, can now be made. The directional properties can be mitigated, and even done away with. Wood can be glued to metal and the uses of both materials extended.

Wood has two important components called cellulose and lignin and these twin components gave birth to paper, films, synthetic rubber, artificial silk, alcohol and various plastics industries.

These developments have taken place in progressive countries and we are left far behind. In these countries, they have developed uses for almost everything coming from the tree, except perhaps the rustle of the leaves. Critical shortages and our increasing population will certainly make us forge ahead in this direction within the next decade.

FUTURE OF OUR FORESTS

The out-turn of timber and fuel for the entire nation is 2,423 cubic feet per square mile of forest, approximately. For Mysore

State, the out-turn is 2,973 cubic feet per square mile, for the area of about 4,500 square miles under Forest Department. Translating this in terms *per capita,* the Indian average amounts to 1·1 cubic foot and for Mysore it will be 1·5 cubic foot. The *per capita* consumption of wood in the different continents is tabulated below, and compared with the figures for India.

Average annual consumption of wood per capita

Continental Group	Timber in c.ft.	Fuel in c.ft.	Total
Europe ..	13·8	14·8	28·6
North and Central America ..	57·6	13·8	71·4
South America ..	5·3	42·8	48·1
Africa ..	1·4	7·8	9·2
Asia ..	1·8	2·1	3·9
Oceania ..	32·8	31·8	64·6
INDIA ..	0·4	0·7	1·1

For the world, the *per capita* consumption of wood is 21·5 cubic feet. These figures show how woefully inadequate and poor our standards are in the utilization of our primary forest products.

All these details freeze down to the fact that in Mysore State we have the annual out-turn of only one-third of an acre for every man, woman and child. In the United States, which is highly industrialized there are still about 4 acres of forest lands for every man, woman and child, these 4 acres being 5½ times more productive in out-turn than ours.

Our task in building up our future forest fortune is therefore enormous. Our demands on our forest wealth will never decrease. They will be always on the increase with our increasing populations, increasing standards of living and depletion of non-renewable resources.

The approach to a solution of our problems ought to be fundamentally œcological, otherwise our apparently nation-building and progressive activities will be but balancing of paradoxes. When there is a lack of œcological appreciation, this becomes inevitable and our specialists will just do their tasks on our public lands simultaneoùsly, without ever realizing that the activities might be conflicting. Great dams will be built for irrigation, and water power without a thought for the watersheds above them. Forests will be thrown open to grazing and burnt, and at the same time afforestation works, and wild life and soil conservation measures will be conceived. Agriculture will be extended, and legislation to protect the semi-parasitic sandal trees in the lands compelled. Mining for minerals will be permitted in forest lands and lamented.

All this could be prevented by recognizing the fundamental œcological approach in the balancing of nature. If the specialists co-operate and see their own fields in relation to the maintenance of biological equilibria, their success is greatest. Thus in our endeavours, Agriculturists, Forest Scientists, Engineers, Public Health and Revenue Officers should be drawn together and teamed in the solution of problems of use of public lands; otherwise unknowingly and unwittingly, each may be working against the objectives of the others. It is only with œcological means that man and nature can be "best friends".

VETERINARY FIRST AID TO CATTLE

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INTRODUCTION

INDIAN agriculture and production of milk depend upon mainly on the upkeep of the cattle wealth of the country. Milk is the only nature's wholesome, best, perfect food of man. Proper care and timely treatment are to be given to cattle as soon as they show any signs of ill-health by qualified veterinary doctors. The least delay, neglect and quackery may lead a simple ailment to serious complications and endanger the very life of the animal. The first aid presented herein is concise and apt to be easily followed by the agriculturist in cases of emergencies, till real veterinary medical aid is sought. Latest simple remedies as well as suitable alternative prescriptions of indigenous drugs easily available in mofussil parts are given to facilitate prompt care.

FIRST AID TO CATTLE

First aid to cattle comprises of restraint, attention to injuries and wounds, treatment of common ailments, snake bite, poisoning, care and management of the sick and finally humane destruction of incurable cases to end their suffering from pain, generally met with after serious accidents. (Humane destruction is omitted here ; please refer such cases to a veterinary surgeon for final decision.)

Restraint.—It is essential that big-sized animals like cattle, are to be properly secured before rendering first aid. Farmers are generally accustomed to secure their animals safely.

Standing Position.—Most of the village cattle have nose strings. Seize the nose string by left hand, secure the horn by right hand which steadies the head. In the case of polled cattle (hornless), steady the head by catching the nostrils with fingers. Carry out examination and dressings in the region of the head, face, forelegs and chest. Tie the head to a post to keep the head under control for prolonged time. Simultaneously secure the hind legs with a milk man's rope just above the hock joint including the tuft of the tail within the knot, which will facilitate manipulation and dressing of the udder, teats, hind legs and other hind parts of the body. Whenever the animal gets restive, just pinch the back for better control.

Casting.—Make a noose at one end of a 10 yard × 1″ thick smooth rope, pass round the base of the horn, or in case of polled cattle fix the noose with the knot to the neck, carry the rope on to the body, make a second round to the chest behind the shoulder, the third one around the abdomen in front of the udder or scrotum, then pull and tighten from the rear ; the man holding the head will raise and turn the head to the opposite direction to which the animal would fall and the other man holding the tail pulling the animal towards the same side to which the animal would fall. Secure all the four legs together by a separate rope. Slacken the rope round the body and neck, keep the head flat on the ground preventing dust and foreign bodies getting inside the eye and breaking of the horns. Release the animal within 10-15 minutes after examining and completing the dressings. Do not cast down full-fed and pregnant animals. Provide good bedding while casting, avoid hard surfaces to prevent injuries and fracture of bones.

I. INJURIES AND WOUNDS

The first aid treatment consists of :

1. Securing the animal and preventing it causing further injury.
2. Arresting heavy bleeding.
3. Cleaning the wound.
4. Application of dressings and bandage.
5. Keeping the animal quiet until bleeding completely stops.

Condition	*Treatment*
(1) SUPERFICIAL WOUNDS AND BRUISES *Cause.*—Fall, friction, barbed wires and collisions, etc. *Extent of Damage.*—Surface layer of the skin is taken off, only skin deapth wound.	*Cleaning.*—Clip the hair round the wound, clean with fresh cotton or a piece of cloth dipped in a weak antiseptic lotion like phenyle (phenyle one teaspoonful to a bucket of water or Condy's fluid, 1 : 1,000) and wipe the part dry. *Dressing.*—Paint the wound with a mixture containing equal parts of tincture of iodine and tincture benzoin Co., and dust dry dressing containing equal parts of boric acid and sulphonamide powder, cover the wound with a layer of dry cotton wool and apply protective bandage. Repeat the dressings once or twice daily until the wound is completely dried. Keep the parts clean. When the above dressings are not available, use the following : Camphor—¼ part ; and Pulvis Turmeric—1 part. Powder and mix well. A good antiseptic dry dressing for external use. Mixed with sweet oil, made into a thin paste, forms a good oily dressing for wounds.
(2) DEEP CUT AND LACERATED WOUNDS *Cause* *Incised Wound.*—By sharp objects. *Lacerated Wound.*—By blunt objects, *e.g.*, horning, barbed wires (the edges of the wound irregular).	*Securing.*—Secure the animal with double ropes to prevent it from further injuring its own wound by horning and licking. *Arresting Haemorrhage.*—In dealing with deep cut wounds, the foremost consideration is to stop bleeding (haemorrhage). Arrest minor bleedings by the application of cold alum lotion (2 drams of alum to a pint of water) and heavy bleeding by direct pressure, plugging the wound cavity with antiseptic plugs such as cotton wool or a piece of clean cloth soaked in a weak lotion of antiseptic or in pure tincture benzoin Co., or in alum lotion and allow the plug to remain inside the wound cavity until bleeding stops. Depending on the degree of hæmorrhage retain the plug inside the wound from 12-36 hours without any harm. As in the case of wounds on the limbs apply temporary pressure bandage above the wound to arrest bleeding.

Cleaning the Wound.—Clip the hair round the wound, irrigate or wash the inside as well as outside of the wound with weak, lukewarm antiseptic lotions like Dettol, potash permanganate, or phenyle, gently remove any foreign body, search for plugs and clots, if any, and remove carefully without injuring the tissues to bleed once again. If the wound has too many pockets inside, a counter-opening has to be made by a surgeon to drain the fluid discharges. Better avail the services of a veterinary surgeon early.

Dressing.—Clean and dry the inside of the wound, apply sulphonamide and cod-liver oil dressing or sulphonamide powder mixed with any sweet oil (sulphonamide powder 1 part, oil 8 parts or *neem* oil and any other sweet oil mixed in equal parts).

In case of deep wounds with cavities, plug a thin piece of gauze or cloth soaked in the dressing oil, one end of which should be hanging out slightly through the mouth of the wound to pull it out easily during the next dressing. Then cover the wound with a layer of thin cotton and apply protective bandage, repeat the dressings once or twice daily till the wound heals.

In case of swelling, give hot water fomentation for 15-20 minutes before dressing the wound.

General Instructions.—Always keep the wound dry and clean, free from flies, prevent soiling with dust, urine, and dung to avoid infection. Provide efficient drainage. Keep the animal in clean surroundings, use only weak antiseptic lotion for dressing, do not unnecessarily interfere with the wound. In simple cases renew dressings once in 24 hours.

(1) *Condy's Fluid.*—Nine grains of potassium permanganate crystals dissolved in 1 pint of water forms 1-1,000 solution, for cleaning of wound and mouth-wash.

(2) Ten stalks of green *neem* leaves, containing about 100 leaves boiled in 1 pint of water for few minutes forms a good antiseptic

Condition	*Treatment*
	lotion for washing and cleaning wounds in place of phenyle or Condy's fluid.
(3) MAGGOTTED WOUNDS Neglected cases of fly-blown wounds which has watery discharge mixed with blood.	As far as possible try to remove the maggots with a pair of forceps. Then plug the wound reaching the deep nests of maggots with cotton or a clean piece of cloth soaked in an oily dressing containing equal parts of oil or turpentine and sweet oil with a little camphor, cover the part with a sufficiently thick pad of cotton so as to asphyxiate the maggots and a protective bandage. Generally after about 6 hours or the next day maggots will be found dead when the bandage is opened ; otherwise repeat the same dressing until all the maggots are destroyed. When once the wound is found free from maggots continue dressings as under deep cut wounds. The following dressings are also useful to destroy maggots from wounds : (1) Juice of custard apple leaves .. .. 4 ounces Camphor .. .. 2 drams Dry tobacco leaves powder .. .. 2 drams Mix well and apply to wounds. Best maggot destroyer. (2) Dry tobacco leaves powder .. .. 4 drams Camphor .. .. .. 1 ounce Sweet oil .. .. 8 ounces Mix well and apply to wounds. A good maggot destroyer.
(4) GUN SHOT WOUNDS	If the injury is not fatal, try to stop bleeding, if any ; cover the wound with antiseptic padding. Immediately approach a veterinary doctor to remove the bullets from the wounds.
(5) WOUNDS CAUSED BY ACIDS, SUCH AS COMMERCIAL SULPHURIC ACID, HYDROCHLORIC ACID, ETC.	Bathe the part with warm soap or weak soda solution in water. Then smear the part with any one of the following as a soothing dressing. White of an egg or milk.

The best is Carron oil emulsion prepared by shaking equal parts of clear limewater with linseed oil or any other bland oil, such as gingelly, groundnut or coconut, etc. (lime water is obtained by shaking lime with water and allowing to settle; the clear liquid at the top which had dissolved some lime is called lime water). In the case of eye instil few drops of castor oil, 3-4 drops to remove irritation.

(6) WOUNDS CAUSED BY STRONG ALKALIS, CAUSTIC POTASH OR CAUSTIC SODA

Bathe the part with a solution of vinegar and water mixed in equal proportions. In the absence of vinegar substitute country *arrack* to prepare the above cooling lotion. Keep the inflamed part wet by means of a bandage. Later continue dressings as under wounds.

(7) INJURIES BY BURNS AND SCALDS

Burns are caused by dry heat, fire, hot metals and scalds by boiling water or moist heat (steam). The injury may take place in any part of the body. The condition is an exceedingly painful one.

As an emergency dressing to relieve the acute pain experienced immediately upon the receipt of a burn apply any one of the following :

Dusting of any flour, rice, ragi or starch flour over the affected area. Thick application of a paste of flour, rice, ragi or starch mixed with water. Smearing white of an egg, milk, honey or treacle. Carron oil emulsion is the best or an emulsion of lime water and milk or decoction of *Goranti* or *Madarangi*[1] leaves. (Do not wash or apply any water over the affected parts.) During latter portion of healing cod-liver oil mixed with sulphonamide powder (powder 1 part, oil 8 parts) is a dressing of choice for speedy cure.

2. Broken Horn

Common accident occurring among cattle, goat and sheep.

Cause.—Falls, struggle with each other in fights.

Classification.—(1) The horn core (bone) is practically broken, the horn is not detached, and there is no open wound.

Class I.—Support the parts temporarily with thin bamboo splints and bandage with adhesives such as red earth, starch to keep the parts in steady position, get veterinary medical aid to apply permanent splints with plaster of paris. The fracture will unite in a month's time.

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[1] *Goranti* or *Madarangi* Henna leaves : *Lawsonia inermis.*

Condition	*Treatment*
(2) The horny covering is completely torn away exposing the core bleeding.	*Class II.*—First paint with a mixture containing equal parts of tincture of iodine and tincture benzoin Co., allow it to dry; if bleeding continues then apply pressure bandage, otherwise apply straightaway a thin coating of Stockholm or common tar and bandage the part covered with a layer of thin clean dry cotton wool or a piece of lint. Alum lotion may also be applied and bandaged to stop bleeding. The horn will not grow once again, but the part will get hard after some time.
(3) Both the horn and core broken leaving ragged edges bleeding, often bleeds most freely.	*Class III.*—Stop bleeding by the application of tincture of iodine and tincture benzoin Co., mixed in equal parts, or alum lotion and pressure bandage. Seek the services of a veterinary doctor; the irregular edges are to be sawed off to the level of the wound. Arrest bleeding, continue daily dressings of sulphonamide with oil or any other antiseptic dressings under expert advice. Great care and cleanliness are necessary to prevent gangrene.
3. Abscess	
A collection of pus in a closed cavity having a covering wall occurring in any part of the body. May be acute (hot) or chronic (cold). *Cause.*—Due to localised bacterial infection. Inflamed neck, very painful swelling.	Paint tincture of iodine, hot fomentation, application of poultice to hasten ripening, requires surgical interference for lancing to evacuate the pus, seek veterinary medical aid. After draining the pus follow dressings as in the case of deep cut wounds.
4. Yoke Gall	
Cause.—Defective yoking, pulling over loaded carts, etc.	In acute cases, during the early stages when the swelling is hot and painful, irrigate with cold water, apply ice-cold packs over the swellings, a pad of cotton or cloth dipped in a cooling lotion like vinegar, *arrack* or methylated spirit, water, in equal parts and keep

the inflamed part wet by repeatedly pouring the cooling lotion over the pad. Replace fresh cold pads 3 or 4 times a day until acute symptoms subside. When the swelling is of few days old, apply hot fomentation, dry, and paint tincture of iodine. Massage the swelling with a stimulating linament consisting of oil or turpentine 4 ounces, camphor 1 ounce and any sweet oil (gingelly, groundnut) 12 ounces, twice daily, will do good to reduce the swelling and pain.

Mustard poultice, warmed and applied, gives beneficial results in bringing down the swelling.

5. Sore Eyes Ophthalmia

Cause.—Result of any injury, blow from a stick, or whip, dirt, presence of foreign bodies, thread-like eye worms (filarial worms) or any infection to the eye.

Symptoms.—Very painful, lid swollen, eye ball blood shot (red) sensitive to light, and there is profuse watery discharge.

Clean the discharge by bathing the affected eye with lukewarm lotion of boric acid or alum (1 dram of boric or alum to a pint of water), search for foreign bodies, remove, if any, and instil a few drops of eye lotion 5-10 drops into the affected eye. Wash the eye 3 or 4 times a day till acute symptoms subside, then twice daily until recovery. Eye requires complete rest and darkness, free from the glare of sunlight. Keep the animal under shade, tie a triangular piece of cloth running from the horn around the face covering the eye. Prevent the animal from rubbing the affected eye against the wall or any other object by fastening the animal with double ropes. Give nourishing and wholesome light food. Whenever available, use of penicillin or aureomycin eye ointment 3 or 4 times a day is more effective, gives better and quicker results. Eye and its structures are highly delicate to handle and one should be careful to avoid complications, hence get veterinary medical aid early.

Eye Lotion

Boric acid	5 grains
Alum	2 grains
Distilled water or clean, boiled and cooled water ..	1 ounce

Condition	*Treatment*
	Mix up thoroughly and drop into the affected eye 3 or 4 times a day.
6. Sore Teat *Inflamed Teat* *Cause.*—Calf nipping the teats, scratches by the nails of the milkers, dirty wet flooring, leaving of the teats wet after milking, etc. *Symptoms.*—Teats become chapped, inflamed and painful, appearance of pimples and sores, cow objects milking and suckling by calf, milk lessens, and gets mixed with discharge, may lead to mastitis.	Check the cause, wash the teats with boric or Condy's lotion, dry the teats after milking, smear penicillin ointment or boric ointment to the sores. Give good bedding and tie the cow in a clean dry place. Fix a fine clean cloth bag to the udder including the teats to prevent soiling and untie during milking. Smearing butter to teats while milking is good, softens the skin for easy milking. Repeat the treatment for a few days until the teats become normal.
7. Sore Feet *Inflamed Feet* *Cause.*—Housing the cattle in wet and filthy places, foreign bodies like gravel, dirt, glass pieces, nails, thorns get stuck up in between the clefts. *Symptoms.*—Swelling of the pastern area, pain and the animal goes lame and unable to bear weight on the affected leg.	Wash the foot with any weak antiseptic lotion like phenyle, remove dirt and foreign bodies, dry, examine and pare the dead hoof, if any. If there is much swelling and pain in the foot, give a foot-bath. Keep the foot immersed in 1% copper sulphate bearably hot solution for half-an-hour. Then dry the part, paint tinctures of iodine to the swellings, apply tar and copper sulphate dressing (copper sulphate 1 dram, tar 4 ounces) to the wound in between the clefts and apply bandage to the foot. Tie a piece of gunny to protect the foot from soiling. Bran mash poultice applied to the foot will also bring down the swelling.
8. Epistaxis (Nose-bleed) *Cause.*—As a result of violent exertion in hot sun, severe hit on the forehead, leeches in the nostrils, severe cough, etc.	Complete rest. Apply cold water and cold packs, ice, if available, on the forehead, gently irrigate or syringe cold alum lotion into the nostrils, keeping the head low to prevent any fluid getting

Symptoms.—Bleeding from the nose, may be from one nostril or both.	into the throat, search for leeches inside the nostrils, easily removed by injecting strong solution of common salt in water inside the nostrils or by rubbing dry salt on the part and when leeches move, pull them out with a pair of forceps. Sometimes withholding drinking water to cattle for 12-24 hours and then allow it to drink, helps leeches to move out or fall into the drinking water. Keeping the head slightly raised during rest will hasten in arresting bleeding. The cold packs over the forehead requires frequent renewal till bleeding stops.
9. Choking Obstruction in the pharynx (throat) or œsophagus (food pipe, gullet). *Cause.*—By swallowing hard and large pieces of food material, mango seeds, onions, potatoes, succulent roots, becoming lodged in the back part of the throat or in any part of the gullet, some times pieces of leather, bone, nails, swallowed along with food become lodged in the gullet. *Symptoms.*—Animal coughs, salivates, shows signs of uneasiness and pain, the water returns from the nostrils while drinking, subsequently develops tympanitis, left side of the abdomen getting distended, at times difficulty in breathing.	Allow the animal loose to move about, not tied; open the mouth, take hold of the tongue to a side, locate the object inside the mouth to the very back part of the throat; if located, remove it gently by inserting a lubricated hand with oil by using the country mouth gag (*Kikola*). In the case of obstruction noticed in the gullet in the shape of swelling or lump along the neck towards the left of the middle line just above the wind pipe, give 4-8 ounces of castor oil or any other sweet oil mixed with equal quantity of lukewarm water by drenching gently, only a little at a time, which will lubricate the gullet as well as the impacted substance and stimulate the gullet to act and force it onwards. Massage the lump like object down and try to dislodge. Round objects with smooth surface usually gets dislodged easily after giving oil. In persisting cases oil drenched return by nostrils. Better repeat often, by giving only a little at a time, allow sufficient time for the object to pass onwards which may happen of its own accord after giving oil. If attempts fail, better seek veterinary aid early.
10. Sprain Inflammation of the muscles, tendons or ligaments over joints due to over-stretch-	In early stages, irrigate the affected part with cold water, apply cold packs or wet bandage. If the animal is able to move, take

Condition	*Treatment*
ing, rupture and laceration of tissues as a result of forced movement. *Cause.*—Slipping, falls, false steps, over-straining of muscles and tendons over joints. *Symptoms.*—The affected parts become hot, swollen, very painful and the animal goes lame or even unable to move.	the animal to a nearby tank, make it stand in water keeping the affected part submerged under water for an hour, morning and evening until acute symptoms subside. Give complete rest to the animal. Massage the part with hand to reduce swelling, subsequently rub turpentine, camphor or ammonia linament, two or three times a day till recovery. If the sprain is not of recent origin, give hot water fomentation to the part and use stimulating linaments as detailed above for few days until the animal becomes normal.
11. Dislocation Displacement of two articular extremities from normal contact from one another, a bone being put out of joint. *Cause.*—Over-stretching, over-exertion and accident. *Symptom.*—Very painful, animal unable to move at times.	Careful examination is necessary by a qualified surgeon before reducing the dislocation as fracture and dislocation may co-exist. If one is not readily available, gently throw down the animal on the healthy side so as to have the dislocated joint uppermost, carefully try to pull the leg and set the part—the head of the bone will be heard to return to its socket with a clicking noise. Give absolute rest to the animal. If there is much pain and swelling, apply cold packs as under treatment in the early stages of sprain. Subsequently use stimulating linaments like ammonia, camphor, or turpentine with gentle massage, give light exercise to promote freedom of movement to the joint, and continue treatment till recovery.
12. Fracture Sudden and violent breakage of a bone. *Cause.*—External violence and force due to a fall or a slip. *Classification.*—*Simple.*—Bone broken, skin is intact over the area. *Compound.*—Bone broken, skin torn	*Handling.*—Avoid adding further injury while removing, examining the animal or setting the fracture. *Healing.*—Natural union of the broken ends take place in about 4-6 weeks time if the broken end of the bones are kept in perfect apposition in their natural position by immobilising the parts with splints and adhesive bandages during the healing period, any

exposing muscle tissues and bones.

Comminuted, Multiple or Complicated.—Skin torn, bone broken in bits injuring muscles and blood vessels.

imperfect reduction or apposition of the parts will end in (malunion) faulty union and deformity. Compound and multiple fractures exposing the inside muscles, tissues and bone are more difficult to tackle, less chance for recovery, warrants immediate presence of a veterinary surgeon for advice or for painless destruction of the animal to end its agony.

Simple fractures, lower down the limbs are easily accessible to treatment, more chance of success in case of young animals as compared to adults. Until the arrival of the veterinary surgeon, the broken ends of the bone may be put in position temporarily supported by bamboo splints sufficiently covered with cloth or cotton and red earth bandage applied. After the fracture is set and plastered by the veterinary surgeon give the animal 4-6 weeks of rest for complete union of the broken ends, nutritious diet, and good bedding. Surgeon should re-examine before bandage is removed.

13. Abortion

Expulsion of the premature fœtus from the womb.

Cause.—Excitement, fright, weakness of the womb, specific infection of the uterus, acute fevers, mechanical injuries.

Avert threatened abortion by separating the animal from the herd, keep the animal in comfortable, well ventilated cow shed, provide good bedding, easily digestible food, gruel, succulent grass and plenty of barley water to drink. Attend to digestive troubles, if any, in the event of any constipation or hard dung sticking up in the rectum, lubricate the hand and fingers with a little castor oil and back-rack the animal gently and give an enema of lukewarm water. Four ounces of castor oil mixed with a little warm milk, drenched to the animal may act as a soothing agent to the bowels in case of any irritation in the stomach. If the animal does not show any improvement, better seek veterinary aid early.

In the meantime if the animal aborts, clean the hind parts of the animal with warm water, give some stimulants such as strong

Condition	*Treatment*
	coffee, country liquor with water and light diet. Burn or bury the fœtus and fœtal membranes deep with a layer of lime. Seek veterinary advice regarding the presence of any suspected infection of contagious abortion in the cow, disinfection of the place, and segregation of the animal to prevent the spread of the infection to other cows in the herd. The milk from cows suffering from contagious abortion should be boiled thoroughly before use. Otherwise it will cause undulent fever in man. *Enema.*—Dissolve a little of the ordinary soap in 1-2 gallons of lukewarm water, pour it into enema can fitted with a rubber tube, pass the other end of the rubber tube into the rectum and allow all the water to flow in. When the tube is taken out, the animal would expel all the fluid out mixed with dung.
14. Retention of Placenta or Afterbirth Remarkable delay in the expulsion of afterbirth. *Cause.*—Generally due to debility, atonic condition of the uterus, any earlier infection in the womb [undue delay and neglect to attend, will result in septic inflammation (metritis) of the uterus, drop in the milk yield].	After calving, give lukewarm water to drink. A full feed of bran mash with a little common salt will prevent cows from eating their own afterbirth in case of animals addicted to such bad habits. Further, fullness of the stomach will throw backward pressure on the uterus which will help speedy expulsion of the after-birth. Keep the hind parts of the animal clean, smear some *neem* oil to the vaginal flaps and surrounding areas to prevent settling of flies and causing fly-blown wounds in the vulval lips which is of common occurrence. Avoid mechanical interference to pull out the after-birth during the first 24-36 hours after calving. Allow the animal to go about grazing ; gentle exercise will assist contraction of the uterus and early expulsion of the afterbirth. Tie a small weight or a small stone with a piece of cloth to the hanging afterbirth which will further help expulsion by gravitation. Take suitable precautions to see that no part of the hanging

membrane gets tampered or torn to pieces by getting entangled into any object. Cover the hind quarters with a piece of gunny tied to the body to prevent crows pecking. It is in vogue in villages to feed cows with fresh, green tender bamboo leaves (shoots) for speedy expulsion of the afterbirth, which may be followed without any ill-effects to the animal. After the stipulated period of 36 hours, it may be possible to remove the entire mass of membrane by gentle traction. Take a thin stick cleaned in Condy's fluid, roll the hanging afterbirth around the centre of the stick over and over until a foot of the hanging membrane is left out, give about half-a-dozen twists by holding the stick at its either ends and pull out the afterbirth by gentle traction. If the whole mass of membrane under twist and traction comes out in tact, then repeat the above process until the whole afterbirth is removed, otherwise do not use force to pull it out as some portion of the membrane may break and be left inside which may give rise to serious inflammation of the uterus. Seek immediately veterinary aid. A cleansing draught containing extract ergot is indicated.

15. Slipping Down of the Womb

Prolapse uterus and vagina, the organs are inverted and thrown out partially or completely.

Cause.—Debility, old age, heavy cows, stall feeding with no exercise, severe straining to expel the fœtus, rough and bad handling while removing the young ones or afterbirth.

Symptom.—The womb is thrown out hanging.

Serious complaint endangering the life of the animal. Get veterinary aid immediately. In the meanwhile keep the inverted organs clean by washing gently with weak Condy's fluid or with good cold water, and covering with a clean towel or cloth. In case of bleeding apply or wash with weak alum lotion (alum 1 dram to pint of water); keep the animal in a quiet place; standing posture is undoubtedly best, elevate the hind quarters one foot or a little more than the front by providing extra bedding or temporary sloping in the floor towards the front which throws the weight of the animal forward and lessens the power to strain. Attract attention of the cow from straining and keep the mouth open, by playing

Condition	*Treatment*
	the hand on the tongue. Straining may also be checked by pinching the back. In case of undue delay to get veterinary aid, secure the cow properly by keeping the hind elevated, clean the inverted portion thoroughly with Condy's fluid or alum lotion suspend it in a clean cloth in level with or even a little higher than the vulva and gently push in by previously lubricated hands with oil applying the fist against the most dependent part and pressing in the protruded mass during the intervals of straining. When the entire prolapsed organ is completely pushed in, insert the bottom end of a clean strong glass narrow-mouthed bottle of 1 pint capacity having two long strings tied to its neck at the centre of strings, into the vaginal cavity leaving the neck outside the vulval lips, which will block the passage for further recurrence of prolapse. Maintain the bottle in position with its bottom inside pressing against the organ by taking the two ends of the string on the top around the base of the tail, the lower ones in between the hind legs around the udder and tying on to a third circular rope tied around the body in front of the udder. Keep continuing the animal in the same hind elevated position till the arrival of a veterinary surgeon for further treatment. It is definitely advisable to refer the case from the very onset, to a veterinary surgeon, to avoid mishandling of the prolapsed uterus which is a highly fragile delicate organ and subsequent danger to the life of the patient.

II. COMMON AILMENTS

1. Stomatitis

Catarrhal inflammation of the mucous lining of the mouth, including tongue and buccal mucous membrane.	Remove the cause, gargle the mouth with lukewarm Condy's fluid or borax, or alum lotion (2 drams of borax or alum to a pint of water). Apply liberally honey mixed with alum or borax (alum

Cause.—Accidentally eating some irritant leaves of herbs while at pasture, feeding of hot gruel, getting access to caustic materials like limewater, licking irritant paints from walls, rough fodder, feeding bearded and spiked cereals, etc.

Symptoms.—Lining mucous of the mouth gets swollen with patches of ulcers, increased salivation with fetid odour a tenacious protective mucous coat arises, the animal goes off feed and difficulty in mastication.

(Stomatitis is a common occurrence in foot and mouth disease.)

2. Tympanites of the Stomach (Rumen)

Hoven or tympany, quick distension of the first stomach (Rumen) with gas, prominently seen on the left side of the abdomen, producing drum-like sound.

Cause.—Over-feeding, ingestion of succulent and frozen grass, brings on rapid fermentation of foodstuffs and produce gas in the stomach.

Symptoms.—Respiratory distress (difficulty to breathe) due to the distended rumen pressing against the lungs, unsteady gait, cessation of rumination of the cud, head poked out, grunts, stands quite stiff, not inclined to move about, eyes become red and thrust out of their sockets, frothy saliva

or borax 2 drams to 1 ounce of honey) inside the mouth and tongue. Repeat the process two or three times a day. Light diet, easily digestible, rice or ragi gruel added with a little jaggery or common salt. Seek veterinary advice to eliminate the possibility of any contagious disease and to attend digestive disorders, if any.

Apply oil of turpentine with equal parts of sweet oil to the distended part on the left side of the abdominal region and massage with hand for about 15-20 minutes with a regulated pressure towards the direction of the tail. Foment the distended part with a towel wrung in hot water. Help eructation of gas from the stomach by pulling the tongue out and keeping the mouth open by the help of wooden mouth gag.

Give an enema of lukewarm water in which little soap is dissolved after back-racking the animal. Drench the following mixture with a thick narrow-mouthed bottle or a bamboo drenching pipe (*Gotta*) to check further fermentation and production of gas in the stomach.

Oil of turpentine	1 ounce
Asafoetida	4 drams
Sweet oil (Groundnut or Gingelly oil)	1 pint

Condition

from the mouth, tongue hanging out, arched back, animal falls down and struggles violently, sour fluids and food discharged from the mouth and nostrils, etc.

Treatment

Mix well and administer. Repeat half the dose after 3-4 hours if no improvement is noticed. While drenching the mixture leave the tongue free, do not raise the head very high, if the animal coughs while drenching release the head till it coughs freely. Do not feed the animal until acute symptoms subside, drinking water in restricted quantities, if no improvement is noticed in a little while, the rumen will have to be punctured with a trocar and cannula (in severe cases), immediately seek veterinary aid for further treatment and surgical interference.

3. Impaction of Rumen

Excess accumulation of foodstuffs in the first stomach (rumen).

Cause.—Over-feeding of indigestible and coarse grass, unground or unsteeped grains, insufficient supply of drinking water.

Symptoms.—Animal refuses food and water, does not chew the cud, grinding of the teeth, bowels constipated, salivation, kicks the hind legs against the abdomen, discomfort, dull. The left side of the abdomen distended and gradually swells, firm and doughy to touch, etc.

Hand massage of the left side of the stomach with a closed fist using oil of turpentine as explained under typany. Back-racking and lukewarm soap water enema. Administer the following mixture.

Oil of turpentine	½ ounce
Asafoetida	4 drams
Ajawan	½ ounce
Sweet oil (gingelly or groundnut oil) ..	1 pint

Asafoetida and Ajawan well powdered and mixed with a little water and then added to oil and drenched.

Withhold solid food until animal passes dung. Liberal supply of water to drink. Drench few bottles of lukewarm water if the animal is not inclined to drink, rub common salt on the back of the tongue to stimulate thirst. Repeat half the dose of the above mixture after 3 or 4 hours if the animal does not show signs of improvement. If the animal shows signs of depression give 8 ounces of country liquor with equal quantity of water. After recovery keep the animal on soft diet, rice or ragi gruel with a handful of common salt and soft green grass with sufficient exercise. Continue digestive powders for few days to improve digestion and to avoid recurrence, as prescribed under constipation.

4. Constipation

Holding of the fæces (dung) in the bowels for more than the normal time.

Cause.—Defective secretion and atonic condition of the bowels, coarse grass, lack of drinking water and exercise, debility, etc.

Symptoms.—Absence or hard dung passed in small quantities at longer intervals, at times mucous coated, grinding of the teeth, foul breath, arched back, inclination to isolate itself from the rest of the herd while at pasture, dull, etc.

Back-rack and enema. Give the following mixture :

Ajawan	6 drams
Ginger (dry)	2 drams
Asafoetida	2 drams
Sweet oil	1 pint

Powder the solids, mix well with oil and drench the animal. Repeat, if required, half the above dose after 6-8 hours. Put the animal under a course of digestive powders for a week. Keep the animal on light, easily digestible, laxative diet, rice or ragi gruel, wheat bran, soft green grass, liberal supply of water to drink, a handful of common salt mixed with feed, and sufficient exercise. Avoid coarse rough fodder.

Digestive Powder

Pulvis Ajawan	6 drams
Pulvis Ginger	2 drams
Ammonium Chloride	2 drams
Soda-bicarb	4 drams

Mix well into a powder (one dose). Given in the food or as a drench in a pint of *conjee* or gruel, twice daily (morning and evening).

5. Diarrhœa and Dysentery

Diarrhœa.—Passage of loose watery stools.

Dysentery.—Loose stools mixed with mucous and blood.

Cause.—Bad food, indigestion, bacterial and parasitic infection, like liver-fluke disease (parasitic diarrhœa).

Symptoms.—Loss of appetite, cessation of

Simple diarrhœa and dysentery are really symptoms of some irritation due to the presence of bad food and irritating substances in the bowels, causing inflammation and preventing normal functions. Treatment should be to remove the offending irritant materials by administering soothing gentle purgatives or laxatives such as castor oil emulsion or linseed oil and then control the motions by astringents and intestinal antiseptics, etc. Give castor oil emulsion 10-12 ounces, or 4-8 ounces of castor oil shaken well with a bottle

Condition

rumination, colicky pains, thirst, constipation at first followed by diarrhœa or dysentery in a day or two, sunken eyes, fetid breath, etc.

Treatment

of lukewarm water. Later continue digestive and astringent powders for few days until motions become normal. Attend to diet, soft easily digestible food like rice, ragi or arrowroot gruel, wheat bran, soft grass, etc.

Castor Oil Emulsion

Castor oil	4 ounces
Gum Acacia	1 ounce
Water	12 ounces

Emulsify the oil with gum and water.

Digestive and Astringent Powder

Chalk (Creta)	½ ounce
Pulvis Catechu	2 drams
Pulvis Cinnamon (Bark powder)	2 drams
Pulvis Ginger	2 drams
Pulvis Anisee	4 drams
Pulvis Ajawan	4 drams

Mix well into a powder (one dose). Give mixed with a pint of water or *conjee* or gruel, twice daily (morning and evening).

In case of young calves, give 2 ounces of castor oil emulsion or 4-8 teaspoonful of castor oil mixed with a little warm milk. Later give the above powders in one teaspoonful dose morning and evening mixed with a little milk. Attend to diet. Arrowroot *conjee* will do more good to calves. Give them less mother's milk till the motions become normal. Sulphaguanidine tablets or Formocibazol whenever easily procurable may be given in consultation with a veterinary doctor, having better results. Depending on the size of the calves 2-4 tablets at a time mixed with a little milk, morning and evening for 3 days and for another 3 or 4 days, half the above dose and then discontinue as these tablets should not be continued longer than 7-10 days at a time.

Specific treatment is indicated for bacterial and parasitic infections; consult a veterinarian.

6. Cold and Cough

Cause.—Exposure to cold, sequelæ to laryngitis, bronchitis or presence of internal parasites.

Symptoms.—Cough during early stages short and dry, later becomes moist and more prolonged with increased mucous secretions, nose dry, eyes watery, discharge from nostrils, etc.

Separate the affected animal from the rest, keep it warm in a quiet and well ventilated place. Apply externally linament of turpentine or oleum eucalyptus to the region of the throat. Inhalation of steam medicated with oil of eucalyptus or oil of turpentine.

Clean the eyes with boric lotion and instil eye drops. Gargle the mouth with borax or alum lotion (alum or borax 2 drams to a pint of water). Then give the following cough powder:

Pulvis Anisee	4-6 drams
Pulvis Glycirriza	4-6 drams
Camphor	1 dram
Borax	2 drams
Honey or Jaggery	1-2 ounces

Mix well into a thin paste (electuary) and rub on the tongue. In respiratory affections strictly avoid drenching the animal, all internal medicines are to be given in the form of an electuary made into a thin paste and rubbed on the tongue or made to eat, as drenching medicine is likely to enter the wind-pipe. Repeat the above (dose) medicine twice daily morning and evening until the animal recovers. Attend to diet, easily digestible soft nutritive food like rice, or ragi gruel, soft grass, wheat bran mash with a handful of common salt, lukewarm water to drink, etc.

7. Bronchitis and Pneumonia

Inflammation starting from the nose extends to the wind-pipe to its branches including lung tissue.

Cause.—Sudden exposure to cold and sequelæ to other contagious diseases.

Same line of treatment as under cold and cough. In addition dry fomentation of the chest wall with hot bran, rub turpentine or camphor linament or oleum eucalyptus, cover the whole body with warm rug, clean the eyes with boric lotion, instil eye drops, gargle the mouth and give some cough powder in the form of paste rubbed

Condition	*Treatment*
Symptom.—Cough, respiratory distress, mucous discharge from nostrils and eyes, breathing through mouth, evidence of pain and heat in the region of the chest, anxious look, fever, refuses food, etc.	on the tongue. Light and nutritious diet, lukewarm water to drink. If the complaint is of a serious nature, better get veterinary aid early and put the animal under penicillin treatment which gives immediate relief to the animal. In the meantime if the animal has not shown much improvement whenever sulpha drugs are available give 12-20 Cibazol or M & B 693 tablets powdered and well mixed with 2 ounces of honey made into a thin paste and rubbed on the tongue preferably half an hour after light feed, repeated morning and evening for 3 days, half the above dose twice daily for another 3-4 days and then discontinue. Sulpha drugs claim beneficial results in respiratory affections.
8. Acute Mastitis Inflammation of the udder is a very serious condition affecting one quarter or all the four simultaneously or at intervals, generally occurring a few days after parturition. *Cause.*—Bacterial origin, infection from filthy ground entering through the teat canal, exposure to chill, lying on cold surfaces, bruises, injury to the udder before or after calving are predisposing factors for the invasion of the bacteria and onset of the disease. *Symptoms.*—Visible swelling of the udder, hard and painful, decrease in milk yield, cow objecting the calf to suckle, hot to touch, difficulty to milk, milk tinged with blood, later lumps mixed with pus, etc.	Relieve intramammary pressure by milking, hot water fomentation to the whole of the udder for 15-20 minutes (by applying moist hot piece of cloth or blanket previously wrung in hot water, while this one gets cold another hot one should be applied). Repeat 2 or 3 times a day. Wipe the udder dry, paint tincture of iodine to the affected parts or massage with any stimulating linament like ammonia, oil of turpentine, or camphor, strip the quarters once in 4-6 hours. Seal orificies at the teat ends with boric or penicillin ointment after milking to prevent further infection getting in and also dress abrasions, if any. In case of heavy udders apply supporting bandages. Udder is a delicate organ to deal with, seek veterinary aid from the very onset. In the meantime, whenever available, penicillin oil wax specially prepared for intramammary use, the contents of one collapsible tube (50,000 units) may be expressed gently into the teat canal after inserting the nozzle into the teat of each of the affected quarters and repeated once or twice in 24 hours after milking for 3 days to a week with good beneficial

results. In addition, antiphlogistin poultice applied to the affected quarters twice daily for 3 or 4 days will reduce quickly much of the swelling and pain. Provide good bedding, keep the cow in clean and dry surroundings, easily digestible and nutritious diet, rest and lukewarm water to drink.

General Instructions.—Segregate and provide a separate attendant, milk healthy cows first if the same attendant is to milk the diseased ones also. The milk and discharges from the affected quarters should be milked last after milking the healthy teats to a separate vessel containing some antiseptic lotion, like phenyle and not on the ground to prevent spreading of the infection. To prevent infection getting in soon after calving or even before, seal the teat ends with penicillin ointment after each milking and dress bruises, if any.

9. Milk Fever

Dropping after calving, generally occurring within 3 or 4 days subsequent to calving or even during the latter part of advanced pregnancy among heavy milch cows, in the majority of cases cows are down within 6-12 hours after calving.

Causes.—Heavy drainage of calcium (hypocalcæmia) from the system (depletion of the calcium content of blood at the moment).

Symptom.—At first erratic behaviour, excited movement, evidence of muscular weakness, hind legs become unsteady, paresis[1] begins, the cow falls on the ground,

Provide good bedding, keep the cow covered with a warm rug, rush to a veterinary surgeon for aid. Injection of calcium borogluconate solution about 200-350 c.c. of 25% solution into the vein (intravenous) as well as under the skin (subcutaneous) is the standard treatment. Soon after injection she will be on her legs. Medicine by mouth is of no avail.

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[1] General paralysis.

Condition	*Treatment*
lies prostrate with loss of consciousness and rests as if in sound sleep, pupil dilated, corneal reflex lost, sometimes eyes closed, cessation of rumination, defecation, urination, extremities getting cold; if not relieved coma and death.	

III. SNAKE BITE AND POISONS

1. Snake Bite

Poisonous and non-poisonous bites may be differentiated by examining the bite holes. *Poisonous.*—Two single rows of small tooth puncture and one relatively larger and deep puncture on each side external to these single rows. *Non-Poisonous.*—Two double rows of numerous tooth punctures. The cobra venom acts on the nervous system, particularly on the respiratory centres. In the case of viper venom action is well noticed locally.	In the case of bites by highly poisonous snakes like cobra the symptoms develop within 5-10 minutes, death is prompt and it is likely to be confused with other contagious disease like anthrax. The local swelling, fang punctures and elimination of any other contagious diseases will throw light on the cause of death. In other cases of bite the symptoms may prolong for hours or even for a day or longer. If the bite be on a limb, a tight ligature should be applied forthwith above the bite so as to prevent absorption of the venom and kept tight for an hour or two. Two or more incisions about ½″ deep should be made with a knife through or over the fang punctures well exposing the underlying tissue and the whole wound compressed to squeeze out the venom. Potassium permanganate crystals should be rubbed well into the incision. In the absence of potassium permanganate the wound may be washed with a strong solution of bleaching powder. Then the wound may be covered with a pad of cotton or clean cloth soaked in strong Condy's fluid or bleaching powder solution and a protective bandage applied. Keep the patient warm, give some stimulants like strong coffee or rum. Get veterinary aid to inject anti-venom serum or for further treatment.

2. Stings by Wasps *Symptoms.*—Causes local painful swelling, irritation, lasts for a day or two. If the bite is in the region of the head, throat and nose, it may cause difficulty in breathing.	Apply weak solution of ammonia or soda to the wounds to neutralise the acid poisoning, strong coffee or rum may be given in case of exhaustion.
3. Heat Stroke and Sun Stroke *Cause.*—Exposure to extreme sun's heat, animals labouring in fields during hot days, etc. *Symptoms.*—Dull, unsteady staggering, sweating, quick and laboured breathing, high body temperature, shivering, convulsion, collapse and death.	Remove the animal forthwith to a cool and shaded place, pour cold water over the head, body and continue cold packs over the head, avoid glare, absolute rest and quietness. After recovery produce the animal before a veterinary doctor for examination and treatment.
4. Poisoning *Cause.*—Poisons, either accidentally picked up with food or maliciously given (criminal poisoning). It may be of either vegetable or mineral origin. Ingestion of tender *jola* shootings in very early pre-flowering stage which contain dangerous amount of hydrocyanic acid prove fatal to cattle if ingested in sufficient quantities. *Symptom.*—Animal becomes suddenly ill, unsteady gait, shows abdominal pain, kicks the belly with hind legs, frequently looks round the flanks, foams at the mouth, at times thirst for water, tetanic twitchings of the muscles of the face, signs of tympany, diarrhœa sets in with mucous and blood, death may occur in about 1-4 hours.	To relieve abdominal pain due to the presence of irritant materials, give castor oil or any other sweet oil as a laxative 4-12 ounces depending on the size of the animal. Foment abdominal region. In case of superpurgation due to irritant poison give demulcent drinks like arrowroot *conjee*, ragi or rice gruel with a little milk. Whenever prostration is noticed give stimulants such as strong coffee, rum or brandy. Poisoning after ingestion of tender *jola* shootings is common among cattle, immediate administration of hyposulphate of soda in doses of ½-1 ounce mixed with 8-12 ounces of water or freshly precipitated ferrous hydrate got from ferri sulph and liquor potasse are indicated to neutralise hydrocyanic acid but such cases should be referred at once to a veterinary doctor. Death suspected due to malicious poisoning should be reported to police or to the veterinary surgeon who would send necessary material for chemical examination and detection of poison.

[*N.B.*—The dose of various prescriptions prescribed in this treatise are for average size adult cattle. Younger ones may be given fractional doses according to their size and age.]

REFERENCE TABLES

	What the numerals in the almanac stand for			Time equivalents	
	Chandramana Day = Thithi	Star = Nakshatra	Yogam	Time	
1	Padyami	Aswini	Bhrama	00–00 = 12	Midnight
2	Bidige	Bharani	Indra	01–00 = 1	Early morning
3	Thadige	Krittika	Vydrithy	02–00 = 2	,,
4	Chouthi	Rohini	Vishkamba	03–00 = 3	,,
5	Panchami	Mrigasira	Preeti	04–00 = 4	,,
6	Shasti	Aridra	Ayushman	05–00 = 5	,,
7	Sapthami	Punarvasu	Soubhagya	06–00 = 6	Morning
8	Ashtami	Pushya	Shobana	07–00 = 7	,,
9	Navami	Aslesha	Athigandha	08–00 = 8	,,
10	Dashami	Makha	Sukarma	09–00 = 9	,,
11	Ekadashi	Pubba	Drithi	10–00 = 10	,,
12	Dwadashi	Uttara	Shoola	11–00 = 11	,,
13	Thriodashi	Hasta	Ganda	12–00 = 12	Noon
14	Chaturdashi	Chitta	Vriddhi	13–00 = 1	Afternoon
15	Poornima or Amavasya (30)	Swathi	Druva	14–00 = 2	,,
16		Vishaka	Vyagatha	15–00 = 3	,,
17		Anuradha	Harsha	16–00 = 4	,,
18		Jyeshta	Vajra	17–00 = 5	Evening
19		Moola	Siddhi	18–00 = 6	,,
20		Poorvashada	Vyathipatha	19–00 = 7	,,
21		Uttarashada	Variyan	20–00 = 8	Night
22		Sravana	Pariga	21–00 = 9	,,
23		Dhanishta	Siva	22–00 = 10	,,
24		Shathabisha	Siddha	23–00 = 11	,,
25		Poorvabhadra	Sadya	23–59 = 11–59	,,
26		Uttarabhadra	Subha		
27		Revati	Sukla		

Auspicious days, stars, *yogams* and months

Days	Stars	Yogams	Months
Monday	Asvini	Preethi	Chitra
Wednesday	Rohini	Ayushman	Vishaka
Thursday	Mrigasira	Soubhagya	Jyeshta
Friday	Punarvasu	Shobana	Sravana
Saturday (only for agricultural business)	Pushya	Sukarma	Bhadrapada Suddha
Sunday	Makha (Marriages)	Dhrithi	Aswayuja
	Uttara	Vriddhi	Karthika
	Hasta	Druva	Margasira
	Anuradha	Harsha	Magha
	Moola (Travel)	Siddhi	Phalguna Suddha
	Uttarashada	Variyan	
	Sravana	Siva	
	Dhanishta		
	Shatabisha		
	Uttarabhadra		
	Revathi		

Abbreviations used

M	Monday	G = General Holiday
T	Tuesday	H = Hindu ,,
W	Wednesday	C = Christian ,,
Th	Thursday	M = Mohammedan Holiday
F	Friday	● = New Moon
S	Saturday	○ = Full Moon
S	Sunday	* = Ekadashi

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ALMANAC FOR
MANMATHA
1955-56

Rahukala and Gulikakala

Manmatha year 1955–56

Rahukala	Days of the week	Gulikakala
4–30 to 6 P.M.	Sunday	3 to 4–30 P.M.
7–30 to 9 A.M.	Monday	1–30 to 3 P.M.
3 to 4–30 P.M.	Tuesday	12 Noon to 1–30 P.M.
12 Noon to 1–30 P.M.	Wednesday	10–30 A.M. to 12 Noon
1–30 to 3 P.M.	Thursday	9 to 10–30 A.M.
10–30 A.M. to 12 Noon	Friday	7–30 to 9 A.M.
9 to 10–30 A.M.	Saturday	6 to 7–30 A.M.

MARCH 1955—Phalguna and Chaitra

JAYA AND MANMATHA

English date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfall nakshatras) Feasts, Festivals, etc.
				Days	Commencing time	No.	Commencing time		
1	T	5 Rajab	18 Kumbha or Masi	7–8 Phalguna S.		3–4		3	
2	W	6	19	9		5		4	
3	Th	7	20	10		6		5	*Poorvabhadra 1st pada*
*4	F	8	21	11		7		6	
5	S	9	22	12		8		7–8	
6	**S**	10	23	13		9		9	
7	M	11	24	14		10		10	
H ○ 8	T	12	25	15		11		11	**Holi Feast** *Poorvabhadra 2nd pada*
9	W	13	26	1 Phalguna Bahula		12		12	
10	Th	14	27	2		13		13	
11	F	15	28	3		14		14	
12	S	16	29	4		15		15	*Poorvabhadra 3rd pada*
13	**S**	17	30	5		15–16		16	Vyasarayaswami P.D.
14	M	18	1 Meena or Panguni	6		16		17	
15	T	19	2	7		17		18	
16	W	20	3	8		18		19	*Poorvabhadra 4th pada*
17	Th	21	4	9		19		20	
18	F	22	5	9		20		21	
19	S	23	6	10		21		22	*Uttarabhadra 1st pada*
*20	**S**	24	7	11		22		23	
21	M	25	8	12		23		24	
22	T	26	9	13		24		25	*Uttarabhadra 2nd pada*
● 23	W	27	10	14–30		25		26	
● 24	Th	28	11	30		26		27	*Uttarabhadra 3rd pada*
					MANMATHA				
G 25	F	29	12	1–2	06–52	27	20–44	1–2	**Lunar New Year's Day**
26	S	1 Shaban	13	3 Chaitra S.	02–53	1	19–02	3	
27	**S**	2	14	4	01–03	2	17–03	4	
28	M	3	15	5	23–02	3	15–40	5	*Uttarabhadra 4th pada*
29	T	4	16	6	20–42	4	14–32	6	
30	W	5	17	7	18–02	5	12–04	7	
31	Th	6	18	8	16–32	6	11–05	8	*Revati 1st pada*

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2 .... are shown on page 248 of the Calendar. The timings are from 12 midnight.

APRIL 1955—Chaitra Suddha and Bahula and Vaishakha Suddha

English date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfall nakshatras) Feasts, Festivals, etc.
				Day	Commencing time	No.	Commencing time		
H 1	F	7	19	9	14–11	7	09–48	9	Sunrise 6–12; set 18–34 **Sri Rama Navami** [mudi Nanjangud Srikanta-
2	S	8	20	10 Chaitra S.	12–09	8	09–01	10	Melkote Vairamudi
* 3	**S**	9	21 Meena or Panguni	11	11–02	9	08–36	11	*Revati 2nd pada,*
4	M	10	22	12	10–00	10	06–31	12	[Ekadasi for all
5	T	11	23	13	9–12	11	08–35	13	
6	W	12	24	14	10–15	12	09–20	14	
M ○ 7[1]	Th	13	25	15	11–13	13	10–46	15	*Revati 3rd pada,* Bangalore Karaga
M C 8[1]	F	14	26	1	1 –26	14	12–42	16	**Good Friday** [1] **Shab-e-Barat**
9	S	15	27	2	14–53	15	15–50	17	*Revati 4th pada*
10	**S**	16	28	3	15–48	16	17–15	18	Easter Sunday
11	M	17 Shaban	29	4	17–44	17	19–52	19	
12	T	18	30	5	19–52	18	22–30	20	Matsya Jayanthi
13	W	19	31	6 Chaitra Bahula	21–48	19	00–44	21	
H14	Th	20	1	7	23–14	20	03–02	22	*Asvini 1st pada* **Tamil New Year's Day**
15	F	21	2	8	00–16	21	04–36	23	
16	S	22	3	9	00–50	22	whole day	24	*Asvini 2nd pada*
17	**S**	23	4	10	01–00	22	06–20	25–26	
* 18	M	24	5	11	00–41	23	06–23	27	
19	T	25	6	12	23–39	24	06–20	1	
20	W	26	7 Mesha or Chittirai	13	22–26	25	06–15	2	*Asvini 3rd pada*
						26	whole day		Sunrise 6–8; set 18–36
●21	Th	27	8	14	20–30	27	06–10	3	
22	F	28	9	30	18–31	1	04–05	4	
23	S	29	10	1	16–23	2	09–34	5	
24	**S**	1	11	2 Vaishakha Suddha	12–42	3	23–44	6	*Asvini 4th pada*
25	M	2	12	3	11–54	4	22–13	7	Basava Jayanthi
26	T	3 Ramzan	13	4	9–44	5	20–18	8	
27	W	4	14	5–6	6–58 4–42	6	18–05	9	Sri Shankara Jayanthi, Sri Ramanuja T.N.
28	Th	5	15	7	2–44	7	17–37		
29	F	6	16	8	0–58	8	17–10	10 11–12	*Bharani 1st pada*
30	S	7	17	9	0–06	9	16–19	13	*Bharani 2nd pada*

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2........ are shown on page 248 of the Calendar. The timings are from 12 midnight.

MAY 1955—Vaishakha Suddha and Bahula and Jyeshta Suddha

English date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfall nakshatras) Feasts, Festivals, etc.
				Day	Commencing time	No.	Commencing time		
1	S	8	18	10	22–54	10	15–50	14	
*2	M	9	19	11 V. S.	22–48	11	16–08	15	
3	T	10	20	12	23–02	12	16–48	16	*Bharani 3rd pada*
4	W	11	21	13	23–50	13	18–22	17	
5	Th	12	22 Mesha or Chittirai	14	00–52	14	20–04	18	Narasimha Jayanthi
○ G 6	F	13	23	15	02–16	15	22–02	19	Vyasa Pournima **Buddha Jayanthi** *Bharani 4th pada*
7	S	14	24	1	04–05	16	00–22	20	
8	S	15	25	2	whole day	17	02 57	21	
9	M	16	26	2–3	06–18	18	05–50	22	
10	T	17	27	3	08–12	19	whole day	23	*Krittika 1st pada*
11	W	18 Ramzan	28	4 Vaishakha Bahula	09–50	19–20	07–55	24	Sunrise 6–00; set 18–30
12	Th	19	29	5	11–17	20	10–04	25	
13	F	20	30	6	12–29	21	11–36	26	
14	S	21	31	7	12–58	22	13–54	27	*Krittika 2nd pada*
15	S	22	1	8	13–05	23	14–05	1	
16	M	23	2	9	12–17	24	14–10	2	
17	T	24	3	10	12–00	25	13–54	3–4	
*18	W	25	4	11	10–48	26	13–12	5	*Krittika 3rd pada*
19	Th	26	5	12	09–07	27	12–14	6	Ascension Day
20	F	27	6 Vrishabha or Vaiyasi	13–14	07–00	1	12–00	7	**Shab-e-Qdr.**
● 21	S	28	7	30	02–10	2	09–22	8	*Krittika 4th pada*
22	S	29	8	1	12–08	3	07–05	9	Sunrise 5–58; set 18–41
23	M	30	9	2	21–22	4–5	06–14 16–34	10	
M24	T	1	10	3 Jyeshta Suddha	18–58	6	02–43	11	**Kutba-e-Ramzan** *Rohini 1st pada*
25	W	2	11	4	16–46	7	01–55	12–13	
26	Th	3 Shavval	12	5	14–43	8	00–41	14	
27	F	4	13	6	13–10	9	24–00	15	
28	S	5	14	7	12–00	10	23–31	16	*Rohini 2nd pada*
29	S	6	15	8	11–02	11	23–44	17	
30	M	7	16	9	10–48	12	00–29	18	
31	T	8	17	10	10–48	13	01–40	19	*Rohini 3rd pada*

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2 ....are shown on page 248 of the Calendar. Timings are from 12 midnight.

JUNE 1955—Jyeshta Suddha and Bahula and Ashadha Suddha

English date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshtras (Rainfall nakshatras) Feasts and Festivals, etc.
				Day	Commencing time	No.	Commencing time		
*1	W	9 Shavval	18 Vaiyasi or Vrishabha	11 J. Suddha	11–30	14	03–08	20	
2	Th	10	19	12	12–43	15	05–02	21	
3	F	11	20	13	14–10	16	whole day	22	*Rohini 4th pada*
4	S	12	21	14	15–51	16	07–26	23	
○5	S	13	22	15	18–00	17	09–24	24	
6	M	14	23	1 Jyeshta Bahula	20–07	18	12–43	25	
7	T	15	24	2	21–47	19	13–04	26	*Mrigasira 1st pada*
8	W	16	25	3	23–02	20	17–17	27	
9	Th	17	26	4	00–11	21	19–09	1	
10	F	18	27	5	01–09	22	20–35	2	*Mrigasira 2nd pada*
11	S	19	28	6	01–09	23	21–03	3	
12	S	20	29	7	00–41	24	21–17	4	
13	M	21	30	8	24–00	25	21–17	5	
14	T	22	31	9	22–17	26	20–35	6	*Mrigasira 3rd pada*
15	W	23	1 Ani or Mithuna	10	20–35	27	20–07	7	
*16	Th	24	2	11	18–43	1	19–09	8	Birthday of Dr. L. C. [Coleman
17	F	25	3	12	17–05	2	18–29	9–10	*Mrigasira 4th pada*
18	S	26	4	13	14–10	3	16–04	11	
●19	S	27	5	14–30	13–32	4	14–05	12	
●20	M	28	6	30	09–32	5	00–43	13	Solar Eclipse
21	T	29	7	1–2 Ashadha Suddha	06–17 05–03	6	11–17	14	*Ardra 1st pada*
22	W	1 Zikhaida	8	3	02–42	7	09–51	15	
23	Th	2	9	4	01–00	8	08–43	16	
24	F	3	10	5	23–31	9	07–50	17	*Ardra 2nd pada*
25	S	4	11	6	21–22	10	07–22	18	
26	S	5	12	7	22–05	11	07–24	19	
27	M	6	13	8	22–20	12	08–10	20	*Ardra 3rd pada*
28	T	7	14	9	23–01	13	09–11	21	
29	W	8	15	10	24–00	14	10–23	22	
*30	Th	9	16	11	01–27	15	12–17	23	*Ardra 4th pada*

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2 .... are shown on page 248 of the Calendar. The timings are from 12 midnight.

JULY 1955—Ashadha Suddha and Bahula and Sravana Suddha

English date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfall nakshatras) Feasts, Festivals, etc.
				Day	Commencing time	No.	Commencing time		
1	F	10 Zilkhaida	17 Mithuna or Ani	12 A. Su.	03–36	16	14–53	24	
2	S	11	18	13	05–41	17	17–17	25	
3	S	12	19	14	whole day	18	18–39	26	
4	M	13	20	14–15	06–23	19	22–17	27–1	
○ 5	T	14	21	15	08–39	20	00–42	2	*Punarvasu 1st pada*
6	W	15	22	1 Ashadha Bahula	10–33	21	02–25	3	
7	Th	16	23	2	11–46	22	03–50	4	
8	F	17	24	3	12–16	23	05–02	5	*Punarvasu 2nd pada*
9	S	18	25	4	12–25	24	05–38	6	
10	S	19	26	5	12–00	25	05–39	7	**[Birthday**
G 11	M	20	27	6	11–02	26	04–52	8	**H. H. The Maharaja's**
12	T	21	28	7	09–50	27	04–20	9	Tikacharyara Punyadina
13	W	22	29	8	08–26	1	03–22	10	*Punarvasu 3rd pada*
14	Th	23	30	9–10	06–06 04–07	2	01–56	11	
* 15	F	24	31	11	01–56	3	00–14	12	
16	S	25	32	12	23–16	4	22–29	13	*Punarvasu 4th pada* [Dakshinayana
17	S	26	1 Kataka or Adi	13	20–43	5	20–29	14–15	Punyakala
18	M	27	2	14	18–05	6	19–31	16	
● 19	T	28	3	30	16–11	7	18–48	17	**Bhimana Amavasya**
20	W	29	4	1 Sravana Suddha	14–15	8	16–53	18	*Pushya 1st pada*
21	Th	1 Zilhaj	5	2	12–19	9	15–55	19	
22	F	2	6	3	11–18	10	15–27	20	
23	S	3	7	4	10–28	11	15–27	21	
24	S	4	8	5	10–00	12	15–41	22	*Pushya 2nd pada*
25	M	5	9	6	10–00	13	16–39	23	**[Garuda Panchami**
26	T	6	10	7	10–39	14	18–50	24	*Pushya 3rd pada*
27	W	7	11	8	11–22	15	19–59	25	
28	Th	8	12	9	12–49	16	22–10	26	
29	F	9	13	10	14–38	17	00–33	27	*Pushya 4th pada* **[Vratam** **Varamaha Lakshmi**
M *30	S	10	14	11	16–40	18	03–14	1	**Bakrid**
31	S	11	15	12	18–34	19	05–02	2	

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2 .... are shown on page 248 of the Calendar. The timings are from 12 midnight.

AUGUST 1955—Sravana Suddha and Bahula and Adhika Bhadrapada Suddha

English date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfal Nakshatras) Feasts, Festivals, etc.
				Day	Commencing time	No.	Commencing time		
1	M	12 Zilhaj	16 Kataka or Adi	13 S. Su.	20–29	20	whole day	3	
2	T	13	17	14	21–55	20	08–02	4	
○ 3	W	14	18	15	23–02	21	10–04	5	**Apasthamba Upakarma** *Aslesha 1st pada*
G 4	Th	15	19	1 Sravana Bahula	23–46	22	11–43	6	**Asvalayana Upakarma**
5	F	16	20	2	00–00	23	12–48	7	*Aslesha 2nd pada*
6	S	17	21	3	23–46	24	13–12	8	
7	**S**	18	22	4	22–29	25	13–24	9	
8	M	19	23	5	21–46	26	13–12	10–11	
9	T	20	24	6	20–20	27	12–28	12	
10	W	21	25	7	18–19	1	11–16	13	*Aslesha 3rd pada*
11	Th	22	26	8	16–10	2	09–14	14	Sri Krishna [Janmashtami
12	F	23	27	9	13–49	3	08–14	15	
13	S	24	28	10	11–26	4–5	07–09 05–25	16	*Aslesha 4th pada*
* 14	**S**	25	29	11	09–04	6	03–47	17	
G 15	M	26	30	12–13	06–39 04–15	7	02–07	18	**Independence Day**
16	T	27	31	14	02–20	8	00–55	19	
● 17	W	28	1 Simha or Avani	30	00–25	9	00–00	20–21	*Makha 1st pada*
18	Th	29	2	1 Adhika Bhadrapada Su.	22–59	10	23–28	22	
19	F	30	3	2	22–17	11	23–24	23	
20	S	1 Muharram	4	3	21–06	12	23–28	24	*Makha 2nd pada*
21	**S**	2	5	4	22–02	13	00–12	25	
22	M	3	6	5	22–32	14	13–24	26	
23	T	4	7	6	23–41	15	15–19	27	
24	W	5	8	7	00–56	16	05–28	1	*Makha 3rd pada*
25	Th	6	9	8	02–54	17	whole day	2	
26	F	7	10	9	04–36	17	07–52	3	*Makha 4th pada*
27	S	8	11	10	whole day	18	10–16	4	
* 28	**S**	9	12	10–11	06–56	19	12–56	5–6	
G 29	M	10	13	11	08–36	20	15–08	7	**Last Day of Muharram**
30	T	11	14	12	10–17	21	17–44	8	*Pubba 1st pada*
31	W	12	15	13	11–28	22	19–10	9	

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2 ....are shown on page 248 of the Calendar. The timings are from 12 midnight.

SEPTEMBER 1955—Adhika Bhadrapada Suddha and Bahula and Nija Bhadrapada Suddha

	English date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfall nakshatras) Feasts, Festivals, etc.
					Day	Commencing time	No.	Commencing time		
	1	Th	13 Muharram	16 Simha or Avani	14 A. B. Su.	12-12	23	20-22	10	
○	2	F	14	17	15	12-41	24	21-08	11	*Pubba 2nd pada*
	3	S	15	18	1 Adhika Bhadrapada Bahula	12-12	25	21-34	12	
	4	S	16	19	2	12-28	26	21-20	13	[Radhakrishnan
	5	M	17	20	3	10-32	27	20-24	14	Birthday of Dr. S.
	6	T	18	21	4	08-50	1	19-24	15-16	*Pubba 3rd pada*
	7	W	19	22	5-6	06-24	2	04-01	17	
	8	Th	20	23	7	02-07	3	17-00	18	
	9	F	21	24	8	23-41	4	15-24	19	Sri Krishna Jayanthi
	10	S	22	25	9	21-17	5	13-50	20	[*Pubba 4th pada*
	11	S	23	26	10	18-53	6	12-11	21	
*	12	M	24	27	11	16-44	7	11-00	22	
	13	T	25	28	12	14-09	8	09-34	23	*Uttara 1st pada*
	14	W	26	29	13	12-39	9	20-06	24	
●	15	Th	27	30	14	11-48	10	07-26	25	Birthday of Sir M.
●	16	F	28	31	30	11-00	11-12	06-41	26	Visvesvaraya
	17	S	29	1 Kanya or Peratasi	1 Nija Bhadrapada Suddha	10-32	12	05-40	27	Samaka Upakarma *Uttara 2nd pada*
	18	S	1 Saffar	2	2	10-17	13	08-07	1	Kanya Sankramana
H	19	M	2	3	3	10-03	14	09-05	2	**Gauri**
G	20	T	3	4	4	12-12	15	10-36	3	**Ganesha**
	21	W	4	5	5	13-28	16	12-40	4	[*Uttara 3rd pada*
•	22	Th	5	6	6	15-34	17	15-04	5	
	23	F	6	7	7	17-30	18	17-42	6	*Uttara 4th pada*
	24	S	7	8	8	19-38	19	20-22	7	
	25	S	8	9	9	21-34	20	22-45	8	
	26	M	9	10	10	23-14	21	01-00	9	
*	27	T	10	11	11	00-30	22	02-36	10	
	28	W	11	12	12	01-14	23	04-06	11	*Hasta 1st pada*
	29	Th	12	13	13	01-36	24	05-18	12	
	30	F	13	14	14	01-06	25	05-55	13	**Anantha Chathurdasi**

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2.......... are shown on page 248 of the Calendar. The timings are from 12 midnight.

OCTOBER 1955—Nija Bhadrapada Suddha and Bahula and Asvija Suddha

English Date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfall nakshatras) Feasts, Festivals, etc.
				No.	Commencing time	No.	Commencing time		
O 1	S	14	15	15 N.B.Su.	00–36	26	04–38	14	*Hasta 2nd pada*
2	**S**	15 Saffar	16 Kanya or Peratasi	1 Nija Bhadrapada Bahula	23–29	27	04–32	15	**Mahatma Gandhi Jayanti**
3	M	16	17	2	21–48	1	03–33	16	
4	T	17	18	3	19–05	2	02–22	17	*Hasta 3rd pada*
5	W	18	19	4	17–44	3	00–55	18	
6	Th	19	20	5	15–37	4	23–04	19–20	
7	F	20	21	6	12–48	5	21–21	21	*Hasta 4th pada*
8	S	21	22	7–8	10–45	6	19–53	22	
9	**S**	22	23	8	08–31	7	18–48	23	
10	M	23	24	9–10	06–15 04–17	8	20–02	24	*Chitta 1st pada*
*11	T	24	25	11	14–36	9	16–02	25	
12	W	25	26	12	13–24	10	15–20	26	Akhiri Charshumbha
13	Th	26	27	13	00–30	11	14–50	27	
14	F	27	28	14	00–16	12	14–50	1	*Chitta 2nd pada*
G●15	S	28	29	30	00–16	13	15–34	2	**Mahalaya Amavasya**
16	**S**	29	30	1 Asvija Suddha	00–57	14	16–34	3	**Commencement of Dasara**
17	M	30	31	2	01–54	15	18–00	4	*Chitta 3rd pada*
18	T	1 Rabi-ul-Avval	1 Tula or Alpisi	3	03–46	16	19–54	5	Thula Sankramana
19	W	2	2	4	05–16	17	22–15	6	
20	Th	3	3	5	whole day	18	00–54	7–8	*Chitta 4th pada*
21	F	4	4	5–6	07–26	19	15–30	9	**Saraswathi Avahana**
22	S	5	5	6	09–14	20	06–40	10	
23	**S**	6	6	7	11–30	21	whole day	11	*Svati 1st pada*
24	M	7	7	8	13–26	21	08–00	12	**Durgashtami**
G 25	T	8	8	9	13–45	22	10–01	13	**Mahanavami**
G 26	W	9	9	10	15–40	23	11–32	14	**Vijayadasami**
*27	Th	10	10	11	15–24	24	12–42	15	[*Svati 2nd pada*
28	F	11	11	12	15–06	25	12–58	16	
M 29	S	12	12	13	14–38	26	12–58	17–18	**Id Meelad**
30	**S**	13	13	14	13–46	27	12–28	19	
O31	M	14	14	15	12–14	1	11–38	20	*Svati 3rd pada*

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2 .... are shown on page 248 of the Calender. The timings are from 12 midnight.

NOVEMBER 1955—Asvija Bahula and Karthika Suddha and Bahula

English Date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfall nakshatras) Feasts, Festivals, etc.
				Day	Commencing time	No.	Commencing time		
1	T	15 Rabi-ul-Avval	15 Tula or Alpisi	1 Asvija Bahula	10–04	2	10–28	21	
2	W	16	16	2–3	07–54 06–06	3	09–14	22	
3	Th	17	17	4	03–02	4–5	07–26	23	*Svati 4th pada*
4	F	18	18	5	00-58	6	04–04	24	
5	S	19	19	6	22–33	7	02–38	25	
6	**S**	20	20	7	20–14	8	01–02	26	*Visakha* 1*st pada*
7	M	21	21	8	18–28	9	00–00	27	Birthday of Sir C. V. [Raman
8	T	22	22	9	17–02	10	23–02	1	
9	W	23	23	10	15–50	11	20–38	2	*Visakha 2nd pada*
*10	Th	24	24	11	14–59	12	20–45	3	
11	F	25	25	12	14–38	13	23–02	4	
12	S	26	26	13	14–38	14	23–59	5	
13	**S**	27	27	14	15–22	15	01–26	6	**Naraka Ch. [Deepavali**
● 14	M	28	28	30	17–02	16	03–22	7–8	Birthday of Pt. J.Nehru *Visakha 3rd pada*
G 15	T	29	29	1 Karthika Suddha	18–20	17	05–52	9	**Bali Padyami** *Visakha 4th pada*
16	W	30	1 Vrischika or Kartikai	2	20–16	18	whole day	10	
17	Th	1 Rabi-us-Sani	2	3	22–10	18–19	08–16	11	Vrischika Sankramana
18	F	2	3	4	01–22	19	10–20	12	
19	S	3	4	5	02–29	20	13–14	13	
20	**S**	4	5	6	03–36	21	15–42	14	*Anuradha* 1*st pada*
21	M	5	6	7	05–08	22	17–52	15	
22	T	6	7	8	whole day	23	19–18	16	
23	W	7	8	9	whole day	24	20–16	17	*Anuradha 2nd pada*
24	T	8	9	10	06–30	25	20–44	18	
*25	F	9	10	11	07–00	26	06–20	19	
26	S	10	11	12	04–28	27	20–06	20	
27	**S**	11	12	13	02–58	1	19–46	21	*Anuradha 3rd pada*
28	M	12	13	14	01–04	2	18–20	22	
○29	T	13	14	15	23–08	3	17–23	23	**Lunar Eclipse** & Vyasa [Pournima
30	W	14	15	1 K.B.	20–44	4	15–42	24	*Anuradha 4th pada*

The Thithies, Nskshatras and Yogams corresponding to the numbers 1, 2 .... are shown on page 248 of the Calendar. The timings are from 12 midnight.

DECEMBER 1955—Karthika Bahula and Margasira Suddha and Bahula

English date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfall nakshatras) Feasts, Festivals, etc.
				Day	Commencing time	No.	Commencing time		
1	Th	15 Rabi-us-Sani	16 Vrischika or Kartikai	2 Karthika Bahula	18–20	5	13–31	25	
2	F	16	17	3	15–56	6	12–20	26	*Jyeshta 1st pada*
3	S	17	18	4	13–22	7	11–54	27	Birthday of Babu
4	**S**	18	19	5	11–24	8	09–20	1	[Rajendra Prasad
5	M	19	20	6	09–28	9	08–16	2	*Jyeshta 2nd pada*
6	T	20	21	7	08–00	10	07–18	3	
7	W	21	22	8	08–16	11	08–40	4	
8	Th	22	23	9–10	06–10 06–00	12	06–34	5	
* 9	F	23	24	11	06–01	13	06–47	6	*Jyeshta 3rd pada*
10	S	24	25	12	whole day	14	07–46	7	[Birthday of C.
11	**S**	25	26	13	06–48	15	08–58	8	Rajagopalachari
12	M	26	27	13–14	07–05	16	10–54	9	*Jyeshta 4th pada*
● 13	T	27	28	14–30	10–10	17	13–01	10	
● 14	W	28	29	30	10–52	18	15–02	11	Solar Eclipse
15	Th	29	30	1 Margasira Suddha	14–14	19	18–05	12	
16	F	1 Jamadi-ul-Avval	1 Dhanus or Margali	2	16–23	20	20–43	13	*Moola 1st pada*
17	S	2	2	3	18–18	21	22–53	14	[Dhanurmasa Puja
18	**S**	3	3	4	19–59	22	01–07	15–16	
19	M	4	4	5	21–11	23	02–57	17	*Moola 2nd pada*
20	T	5	5	6	21–55	24	03–54	18	
21	W	6	6	7	22–09	25	04–38	19	
22	Th	7	7	8	21–55	26	04–52	20	*Moola 3rd pada*
23	F	8	8	9	21–11	27	04–33	21	
24	S	9	9	10	18–49	1	03–54	22	
* 25	**S**	10	10	11	18–33	2	02–49	23	Vaikunta Ekadasi [**Christmas**
26	M	11	11	12	16–37	3	01–30	24	*Moola 4th pada*
27	T	12	12	13	14–43	4	01–25	25–26	
28	W	13	13	14	12–17	5	10–38	27	
○ 29	Th	14	14	15	08–57	6	08–57	1	*Poorvashadha 1st pada*
30	F	15	15	1–2 M.B.	07–35 04–58	7	07–22	2	
31	S	16	16	3	03–31	8	18–57	3	

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2 .... are shown on page 248 of the Calendar. The timings are from 12 midnight.

JANUARY 1956—Margasira Bahula and Pushya Suddha and Bahula

English date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfall nakshatras) Feasts, Festivals, etc.
				Day	Commencing time	No.	Commencing time		
1	**S**	17 Jamadi-ul-Avval	17 Dhanus or Margali	4 Margasira Bahula	01–22	9	16–28	4	**New Year's Day**
2	M	18	18	5	23–01	10	15–36	5	[*Poorvashadha 2nd pada*
3	T	19	19	6	20–03	11	14–52	6	
4	W	20	20	7	21–19	12	14–37	7	*Poorvashadha 3rd pada*
5	Th	21	21	8	21–04	13	14–52	8	
6	F	22	22	9	21–19	14	15–36	9	
7	S	23	23	10	21–53	15	16–38	10	
*8	**S**	24	24	11	23–19	16	18–20	11	*Poorvashadha 4th pada*
9	M	25	25	12	01–56	17	20–44	12	
10	T	26	26	13	03–08	18	23–04	13–14	
11	W	27	27	14	06–15	19	01–28	15	*Uttarashadha 1st pada*
● 12	Th	28	28	30	whole day	20	04–05	16	
● 13	F	29	29	30	08–40	21	whole day	17	
G 14	S	30	1 Makara or Tai	1 Pushya Suddha	10–01	21	08–54	18	**Uttarayana Punyakala** [*Uttarashadha 2nd pada*
15	**S**	1 Jamadi-us-Sani	2	2	11–40	22	08–54	19	
16	M	2	3	3	13–02	23	09–49	20–21	
17	T	3	4	4	13–49	24	11–49	22	*Uttarashadha 3rd pada*
18	W	4	5	5	13–49	25	12–31	23	
19	Th	5	6	6	13–31	26	12–47	23	
20	F	6	7	7	12–47	27	12–47	24	*Uttarashadha 4th pada*
21	S	7	8	8	11–49	1	12–03	25	
22	**S**	8	9	9	10–09	2	11–07	26	
*23	M	9	10	10–11	08–13 06–31	3	09–55	27	*Sravana 1st pada*
24	T	10	11	12	03–49	4	08–13	1–2	
25	W	11	12	13	01–25	5–6	06–48 05–40	3	
G 26	Th	12	13	14	22–08	7	03–40	4	**Republic Day**
O27	F	13	14	15	20–44	8	01–59	5	[*Sravana 2nd pada*
28	S	14	15	1 Pushya B.	18–30	9	12–34	6	
29	**S**	15	16	2	16–52	10	23–36	7	
30	M	16	17	3	15–26	11	22–53	8	*Sravana 3rd pada*
31	T	17	18	4	14–25	12	22–38	9–10	

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2 .... are shown on page 248 of the Calendar. The timings are from 12 midnight.

FEBRUARY 1956—Pushya Bahula and Magha Suddha and Bahula

English date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfall nakshatras) Feasts, Festivals, etc.
				Day	Commencing time	No.	Commencing time		
1	W	18	19	5	13-32	13	22-38	11	
2	Th	19	20	6	13-03	14	22-57	12	*Sravana 4th pada*
3	F	20	21	7	13-32	15	23-45	13	
4	S	21 Jamadi-us-Sani	22 Makara or Tai	8 Pushya Bahula	14-27	16	02-00	14	
5	**S**	22	23	9	15-40	17	03-54	15	*Dhanishta 1st pada*
6	M	23	24	10	17-22	18	04-37	16	
*7	T	24	25	11	19-32	19	whole day	17	
8	W	25	26	12	21-22	19	08-40	18	*Dhanishta 2nd pada*
9	Th	26	27	13	23-20	20	11-22	19	
10	F	27	28	14	01-16	21	14-00	20	
●11	S	28	29	30	02-58	22	16-06	21	
12	**S**	29	30	1	04-23	23	18-18	22	
13	M	1	1	2	04-32	24	19-16	23	*Dhanishta 3rd pada*
14	T	2	2	3	04-20	25	20-28	24	[Kumbha Shankramana
15	W	3	3	4	04-51	26	20-48	25	
16	Th	4	4	5	04-09	27	20-42	26	*Dhanishta 4th pada*
17	F	5	5	6 Magha Suddha	02-43	1	20-13	27	
18	S	6	6 Kumbha or Masi	7	12-47	2	19-15	1	
19	**S**	7	7	8	22-47	3	17-37	2	*Satabhisha 1st pada*
20	M	8 Rajab	8	9	20-39	4	16-33	3	
21	T	9	9	10	18-29	5	15-07	4	
*22	W	10	10	11	16-19	6	14-27	5-6	*Satabhisha 2nd pada*
23	Th	11	11	12	13-55	7	12-45	7	
24	F	12	12	13	12-43	8	10-05	8	
25	S	13	13	14	09-21	9	08-53	9	
○26	**S**	14	14	15-1	08-29 06-00	10	02-40	10	*Satabhisha 3rd pada*
27	M	15	15	2 M.B.	06-30	11-12	06-43	11	
28	T	16	16	3	04-19	13	06-15	12	
29	W	17	17	4	04-32	14	whole day	13	*Satabhisha 4th pada*

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2........ are shown on page 248 of the Calendar. The timings are from 12 midnight.

MARCH 1956—Magha Bahula and Phalguna Suddha and Bahula

English date	Days of the week	Mohammedan	Sowramana	Chandramana		Nakshatras		Yogam No.	Mahanakshatras (Rainfall nakshatras) Feasts, Festivals, etc.
				Day	Commencing time	No.	Commencing time		
1	Th	18 Rajab	18 Kumbha or Masi	5 Magha Bahula	04–17	14	06–57	14	
2	F	19	19	6	05–59	15	07–27	15	
3	S	20	20	7	06–24	16	09–07	16	*Poorvabhadra 1st pada*
4	**S**	21	21	8	whole day	17	11–03	17	
5	M	22	22	8	08–05	18	13–11	18	
6	T	23	23	9	10–19	19	15–51	19	
7	W	24	24	10	11–59	20	18–25	20	*Poorvabhadra 2nd pada*
*8	Th	25	25	11	14–20	21	21–03	21	
9	F	26	26	12	16–15	22	23–14	22	
10	S	27	27	13	17–41	23	01–19	23	*Poorvabhadra 3rd pada*
11	**S**	28	28	14	18–39	24	02–49	24	**Mahasivarathri**
●12	M	29	29	30	19–08	25	03–47	25	
13	T	30	30	1 Phalguna Suddha	19–16	26	03–54	26	*Poorvobhadra 4th pada* Meena Sankramana
14	W	1 Shaban	1 Meena or Panguni	2	18–32	27	05–22	27	
15	Th	2	2	3	17–50	1	03–02	1	
16	F	3	3	4	16–23	2	02–28	2–3	
17	S	4	4	5	14–42	3	01–44	4	*Uttarabhadra 1st pada*
18	**S**	5	5	6	12–47	4	00–18	5	
19	M	6	6	7	10–38	5	22–38	6	
20	T	7	7	8–9	08–14	6	17–04	7	*Uttarabhadra 2nd pada*
21	W	8	8	10	08–26	7	19–16	8	
* 22	Th	9	9	11	12–57	8	18–52	9	Vairamudi at Melkote
23	F	10	10	12	23–06	9	16–23	10	
24	S	11	11	13	21–11	10	14–11	11	*Uttarabhadra 3rd pada*
25	**S**	12	12	14	19–30	11	14–14	12–13	
○26	M	13	13	15	18–04	12	13–44	14	
27	T	14	14	1 P. Bahula	17–50	13	13–44	15	*Uttarabhadra 4th pada*
28	W	15	15	2	17–34	14	13–59	16	
29	Th	16	16	3	18–03	15	14–52	17	
30	F	17	17	4	18–58	16	16–04	18	*Revati 1st pada*
31	S	18	18	5	20–00	17	17–46	19	

The Thithies, Nakshatras and Yogams corresponding to the numbers 1, 2 .... are shown on page 248 of the Calendar. The timings are from 12 midnight.

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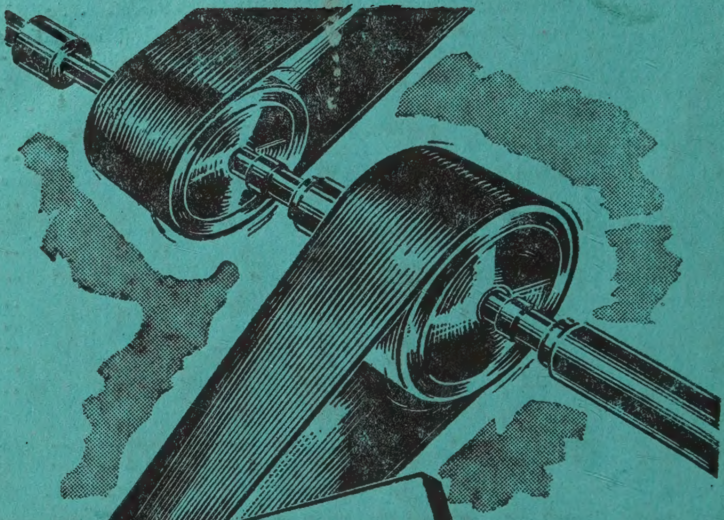

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